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THE ROENTGEN DIAGNOSIS OF DOUBLE AORTIC ARCH AND OTHER ANOMALIES OF THE GREAT VESSELS*

By EDWARD B. D. NEUHAUSER, M.D.
BOSTON, MASSACHUSETTS

THE MAJOR anomalies of the aortic arch and great vessels at the base of the heart have been well known to anatomists and pathologists for many years, but until the present time many of these anomalies have been considered of academic interest only. However, with perfection of surgical technique and mastery of the problems of preoperative and postoperative care, most of those anomalies that are disabling or fatal in their effects are now amenable to surgical cure or improvement.

The following classification has been adopted for the purposes of this discussion:

I. *Right Aortic Arch*
  A. Situs inversus viscerum
  B. Right aortic arch without inversion
    1. Anterior type—The aortic arch is anterior to the trachea, and the descending aorta is on the right side.
    2. Posterior type—The aorta passes to the left behind the esophagus, and the descending aorta courses to the right of the normal left-sided position.
      a. Right aortic arch in which the left subclavian artery arises last from the arch and crosses behind the esophagus to its distribution.
      b. Right aortic arch in which no vessel arising from the arch crosses the midline posterior to esophagus.
      c. Right aortic arch with a persistent left aortic diverticulum giving origin to the left subclavian artery. No vessel from the arch crosses the midline posteriorly.

II. *Double Aortic Arch*
  A. Both aortic limbs patent
  B. One aortic limb obliterated

III. *Anomalous Right Subclavian Artery*. The artery arises last from a normal aortic arch and crosses the midline to its distribution on the right side.

IV. *Patent Ductus Arteriosus*

V. *Coarctation of the Aorta*

Although knowledge of the development of the six-paired aortic arches that develop during embryonic life is essential for a

* From the Department of Roentgenology, the Infants' and the Children's Hospitals, and Department of Radiology, Harvard Medical School, Boston, Mass.

Fig. 1. M.O'D., infant female. Persistent posterior right aortic arch with vascular ring formed by the pulmonary artery and the patent ductus arteriosus. There is a large rounded pressure defect on the posterior aspect of the esophagus at the level of the aortic arch. The trachea is narrowed and is displaced forward. Pressure from the common carotid evidently produced the narrowing of the trachea just above the level of the aortic arch, and pressure from the pulmonary artery produced pressure changes just below the level of the arch.

complete understanding of the pathenogenesis of these anomalies, only a minimum will be presented in this paper as the subject has been discussed in many papers and texts of embryology,[3,7,11] and will be completely covered in a paper to be published by Owyang and Farber.

There are six pairs of aortic arches that develop at various times in the embryo. The cephalad arches develop first only to disappear as the more distal develop. The final normal pattern of development is thought to be as follows: the proximal part of the third arch becomes the common carotid. The left fourth becomes the aorta, while the proximal part of the right fourth arch becomes incorporated in the right subclavian. The proximal parts of the sixth becomes the pulmonary arteries, and the distal part of the left sixth becomes the ductus arteriosus. Normally, the other portions of the arches disappear. Anomalies of the great vessels result from persistence of normally obliterated arches or segments, with disappearance of portions that should normally be present.

The clinical significance of these anomalies and methods of cure by surgical means will be discussed in a companion paper from the Children's Hospital by Gross and Ware.[19] In my paper the discussion will be

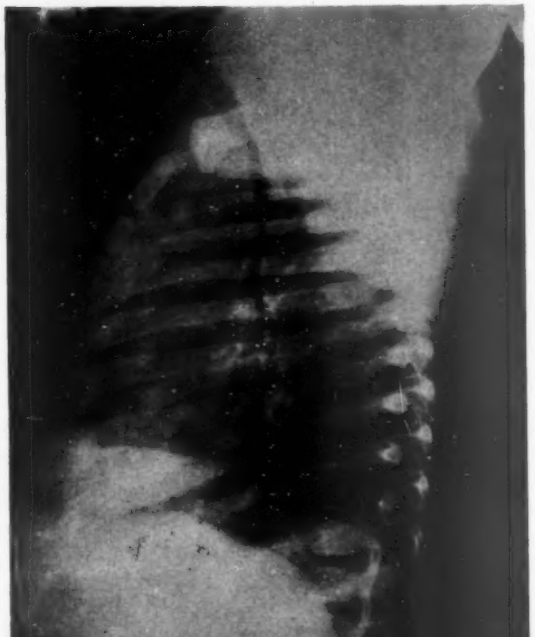

Fig. 2. R.K., infant male. Vascular ring, probably a double aortic arch. Patient has stridor and occasional attacks of bronchitis. The symptoms have not been sufficiently severe to warrant operation. Lateral roentgenogram of the chest shows slight anterior displacement of the trachea with considerable narrowing at the level of the aortic arch.

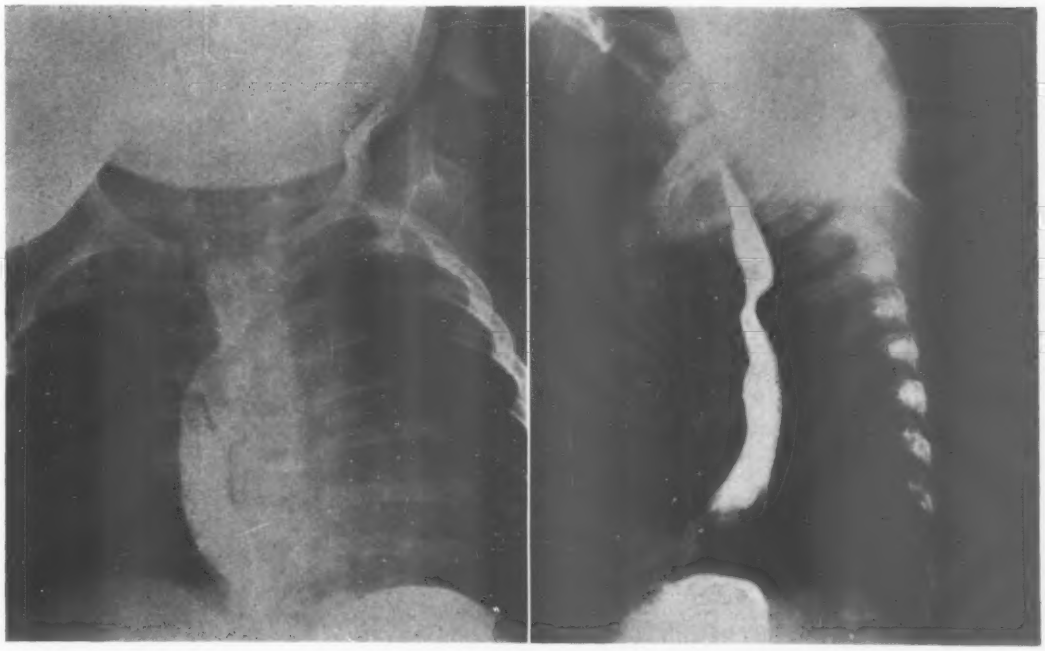

Fig. 3. R.K., infant male, same case as Figure 2. Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus. There is no lateral shift of the esophagus but there is marked narrowing of the esophagus from both the right and the left sides. In the lateral projection the large rounded posterior defect produced by the right aortic arch is clearly seen, and there is less well defined pressure on the anterior aspect.

limited to the roentgen diagnosis and it is to be emphasized that in many of these conditions the diagnosis can be made only by means of an adequate roentgenologic examination. The criteria for roentgen diagnosis is understood in many of these anomalies and in such cases a brief résumé of the salient features and appropriate references will be given.

Right Aortic Arch. There have been many excellent papers[5,6,9] devoted to the roentgen diagnosis of right aortic arch, and repeated reference must be made to the excellent and thorough study by Fray.[7] The diagnosis of right aortic arch can be made only by roentgenologic examination. The diagnosis can be frequently suspected from the posteroanterior roentgenogram alone as the aortic arch may be observed to be the right of the midline with absence of the aortic "knob" from its usual position. The main portion of the shadow of the "knob" is cast by the descending limb of the aortic arch and, as this limb lies either in the midline or to the right of the midline in most cases, the "knob" is not seen in its usual position. In addition, there may be very slight deviation of the trachea to the left. The determination of the exact type of right aortic arch must be made by observing the deflections and defects in the barium-filled esophagus.

The right aortic arch associated with situs inversus viscerum is of course part of transposition of all of the viscera or of dextrocardia alone and need not be considered here. The anterior right arch without inversion will produce a defect on the right side of the esophagus and possibly produce a slight displacement of the trachea and esophagus to the left. There should be no defect on the posterior aspect of the esophagus. These two anomalies are of little importance as symptoms from the arch deformity alone are not to be expected. There is no embryological relationship of this anomaly to the other deformities considered in this paper.

The recognition of the posterior right aortic arch and its clear differentiation from double aortic arch and an anomalous right subclavian artery is of considerable importance as it is these malformations which may lead to severe and disabling symptoms. A posterior right aortic arch passing behind the esophagus with the descending limb passing to the right of the normal left-sided position may be of three types. In each the basic deformity of deviation of the esophagus to the left with a rounded defect on the right lateral aspect and on the posterior aspect of the esophagus will be evident. In type 2a, where in association with the posterior right aortic arch, the left subclavian arises as the last vessel from the arch the basic deformity will be modified as Renander[16] has shown. The left subclavian as it passes to the left side behind the esophagus to its distribution creates on the posterior aspect of the esophagus an oblique defect running upward from right to left just above the defect produced by the right arch itself. This deformity is illustrated in the paper by Gross and Ware.[19]

The posterior right aortic arch type 2b appears to be the one most commonly recognized roentgenologically, and in nearly all cases the basic deformation of the barium-filled esophagus is all that is seen, as no vessel arising from the arch crosses the midline so as to produce a pressure defect on the esophagus. However, in the rare instance when symptoms are produced, as shown in Figure 1 a vascular ring is formed by the pulmonary artery and the ductus arteriosus or ligamentum arteriosum. The pulmonary artery is pulled back against the anterior aspect of the trachea by the ductus and will produce compression of the trachea as seen in the lateral view and probably a pressure defect on the left side of the esophagus at the level of the ductus as seen in the anteroposterior pro-

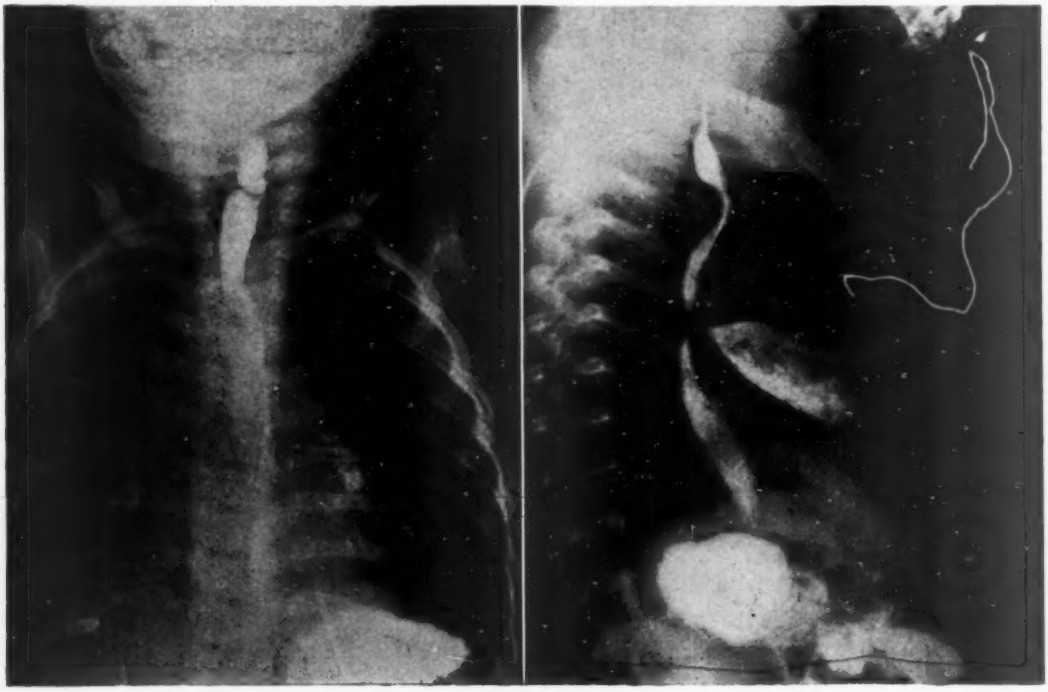

Fig. 4. F.R., infant. Double aortic arch proved at operation, and fully reported by Gross.[10] Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus. The appearance is essentially similar to that shown in Figure 3. The defect produced by the persistent posterior right aortic arch showed visible pulsation during roentgenoscopic examination, and there is erosion of the anterior aspect of several vertebral bodies at the level of the right arch. There is lipiodol in the partially atelectatic right middle lobe.

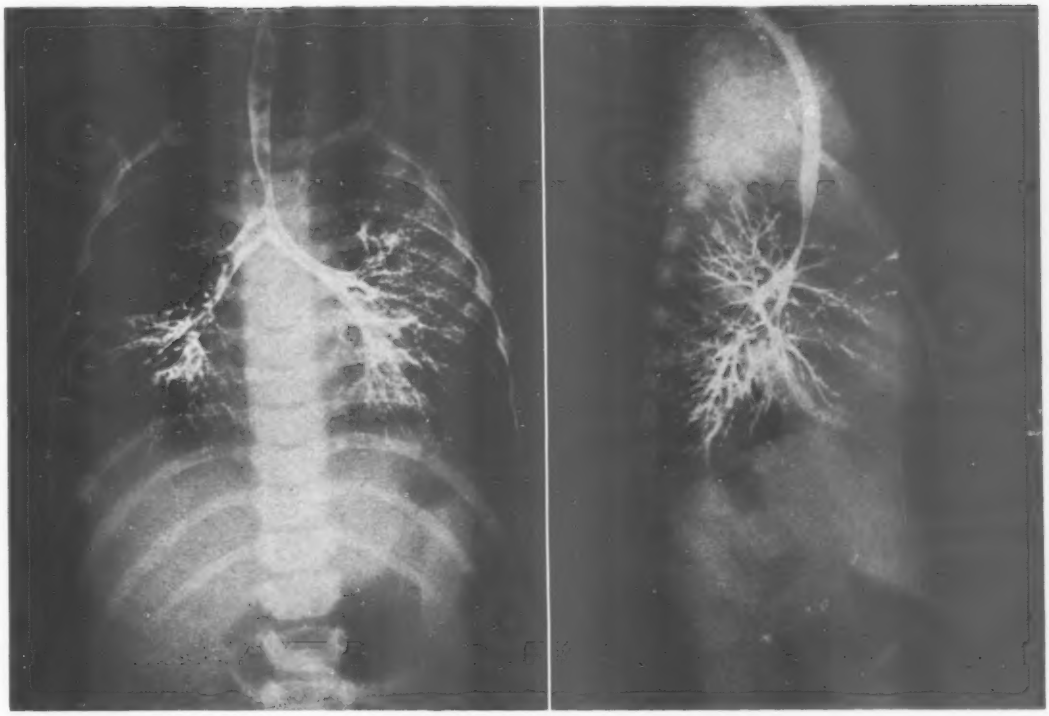

Fig. 5. F.R. Anteroposterior and lateral roentgenograms of the chest following instillation of lipiodol. There is marked narrowing of the trachea in all diameters just above the bifurcation at the level of the aortic arches.

jection. The common carotid also passes in front of the trachea from right to left and may contribute to the tracheal compression. The deformity produced by this type of constricting ring can be distinguished only with difficulty from that produced by a double aortic arch, particularly if the anterior limb of the double aortic arch is obliterated as occasionally occurs. The posterior defect in the barium-filled esophagus produced by the posterior right arch alone is of a size that would be associated with an aorta of the usual diameter, while in the double aortic arch the posterior defect is rarely more than half the expected size if both arches are patent. In the patient with evidence of tracheal and esophageal compression operative intervention to relieve the constriction is imperative. Undoubtedly in most patients the vascular ring is sufficiently loose so that no compression can be recognized.

The third form of posterior right aortic arch, class 2c, where there is persistence of a left aortic diverticulum giving origin to the left subclavian artery roentgenologically can be distinguished only with difficulty from the previous type as no vessel crosses the midline behind the esophagus. Fray[7] states that the defect on the posterior aspect of the esophagus in this type is due to the aortic diverticulum. Arkin[2] was able to visualize the diverticulum as it produced in his cases a shadow of increased density in the region of the posterior arch of the aorta behind the esophagus, that could be distinguished from the shadow of the arch itself. Tracheal compression from the pulmonary artery and ductus arteriosus may occur in association with this type of anomalous arch in a manner similar to that described for the second type.

Double Aortic Arch. The roentgen diagnosis of double aortic arch producing constriction of both the trachea and esophagus has been made four times at the Children's Hospital. Two of these patients have been

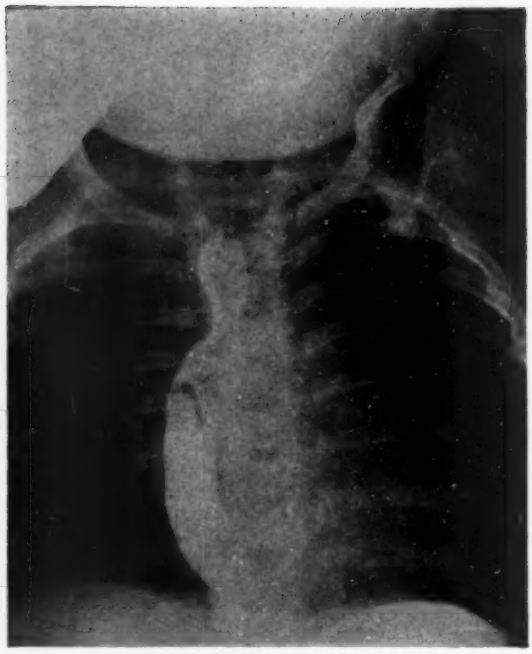

Fig. 6. C.G., infant female. Double aortic arch proved at operation. Anteroposterior roentgenogram of the chest with barium in the esophagus. There is rather marked encroachment on the esophagus from both the right and left sides without deviation of the esophagus.

operated upon by Dr. Robert E. Gross, and one case has been presented at considerable length.[10] It is well known that occasionally a double aortic arch is found at autopsy or at the time of an anatomical dissection where it has been evident that no severe symptoms were produced. In this paper we are primarily interested in the constricting double arch that produces, as Wolman[18] has described, a rather characteristic clinical picture in infants, although the diagnosis rests solely on roentgenographic examination. The onset of symptoms is usually in infancy and the patients with this syndrome usually present stridorous breathing, mild dysphagia, head retraction, chronic cough, and frequent attacks of pulmonary infection. The stridor is usually made worse by feeding.

In our 4 patients (Fig. 2 to 10) the roentgen changes appeared to be unmistakable and characteristic. In the posteroanterior projection we have not been able to detect any abnormality of the heart or great vessels when no contrast substance was used as it is extraordinarily difficult to detect the position of the aortic arch in the young infant; but in the lateral projection it is possible to see narrowing and anterior displacement of the trachea at the level of the aortic arch. When the esophagus is filled with barium there appears a rounded pulsating mass posterior to the esophagus and this mass, the posterior right aortic arch, displaces the esophagus forward. In one of our patients there was apparent erosion of the anterior aspect of several of the vertebral bodies at the level of the aortic arch. This erosion was evidently due to the pulsation of the posterior arch in contact with the prevertebral soft tissues. In the anteroposterior projection there is no deviation of the barium-filled esophagus to

Fig. 7. C. G. Proved double aortic arch. Lateral roentgenogram of the chest with barium in the esophagus shows the characteristic posterior defect of the posterior right aortic arch but this is associated with pressure defect on the anterior aspect. This patient had severe symptoms of stridor, dysphagia and recurrent pulmonary infection.

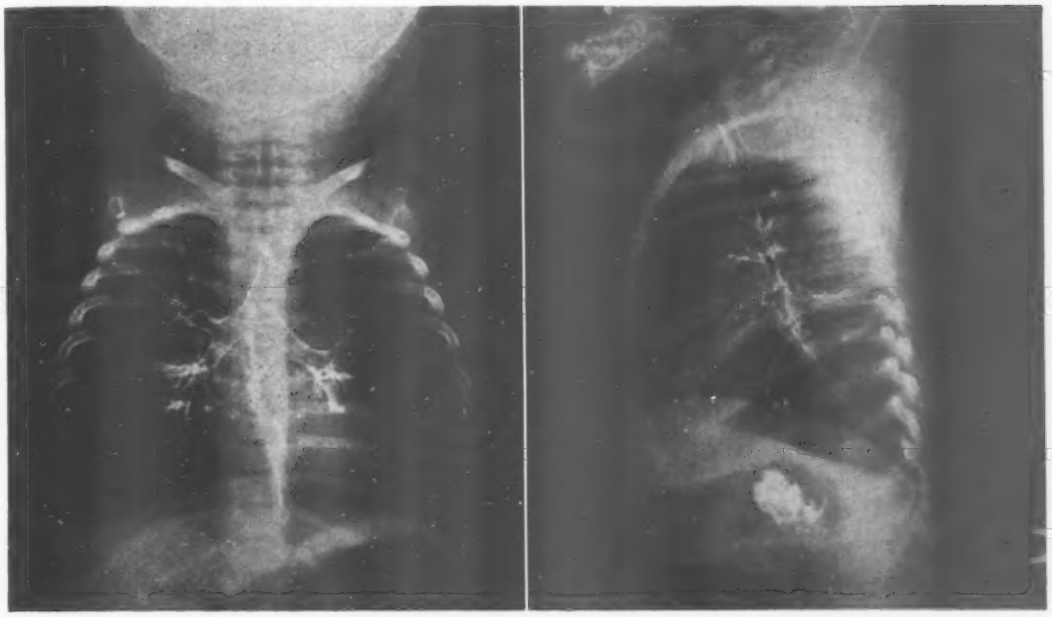

FIG. 8. C.G. Roentgenograms of the chest following instillation of lipiodol into the tracheobronchial tree. The appearance is apparently identical to that illustrated in Figure 5. There is slight anterior displacement of the trachea with narrowing in all diameters at the same level as the defects in the esophagus.

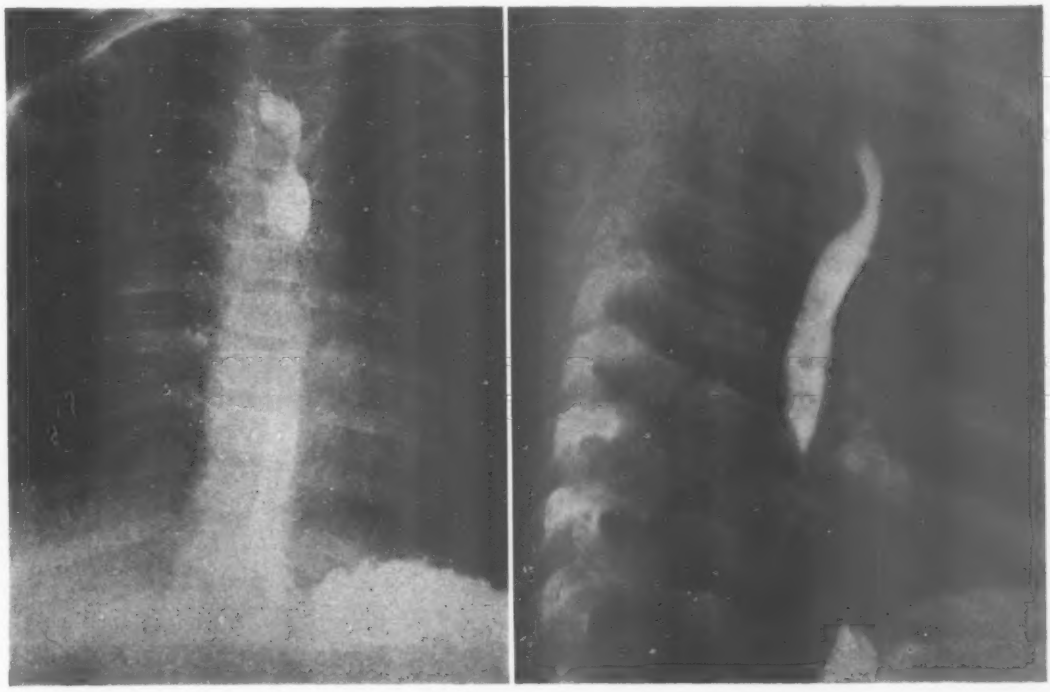

FIG. 9. S.L., infant female. Vascular ring, probably a double aortic arch. The patient has mild dysphagia and moderate stridor. The vascular ring evidently produces only moderate constriction. Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus show at the level of the aortic arch a defect on the right and on the left sides, and a large defect posteriorly with moderate forward displacement. There seems to be very little pressure on the anterior aspect of the esophagus.

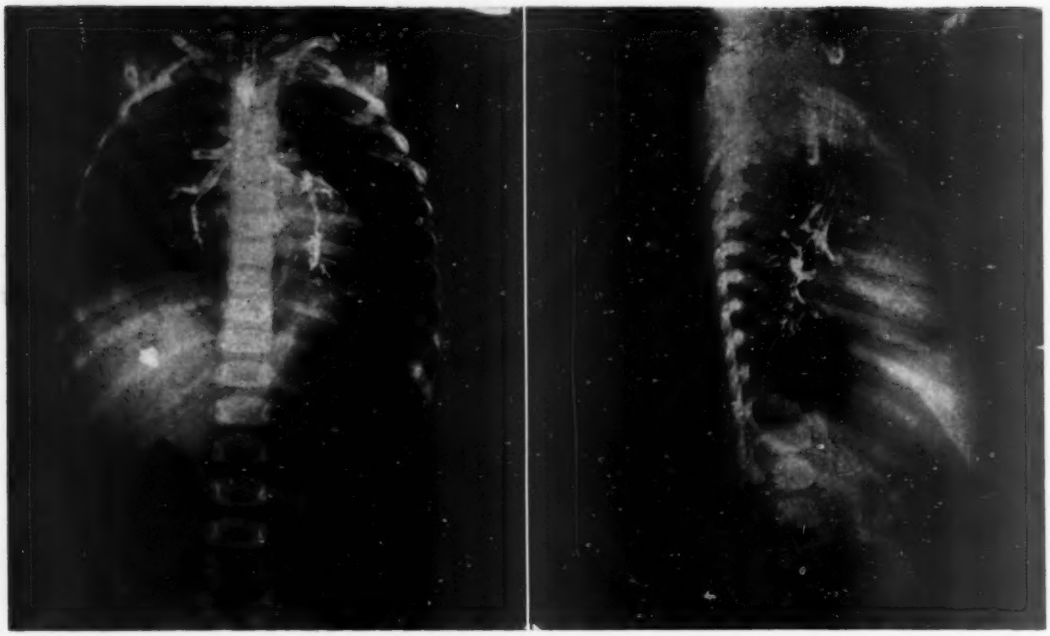

Fig. 10. S.L. Lipiodol roentgenograms show the deformity of the trachea characteristic of a vascular ring. The ring is probably quite loose as there is little evidence of pressure on the anterior aspect of the trachea. Some of the lipiodol has been swallowed and the deformity of the esophagus can be seen in relation to that of the trachea.

the left as is seen with the right aortic arch alone, but rather there is narrowing of the esophagus from both the right and the left sides due to the pressure of the vascular ring. Although these findings would appear to be diagnostic it seems wise to obtain satisfactory roentgenograms of the trachea after the instillation of a suitable opaque oil. When this is done a deformity of the trachea is seen similar to that visualized in the esophagus. The trachea is displaced forward at the level of the right aortic arch and it is narrowed from both the right and left sides by the pressure of the vascular ring and pressed upon by the left aortic arch anteriorly.

In each of the 2 patients operated upon there was an apparently identical anatomical variant which is described at greater length by Gross and Ware. The aorta arose normally from the left ventricle, but at the level of the arch divided into a posterior right aortic arch which passed behind the esophagus and into a left aortic arch which passed anterior to the trachea. The two vessels then united to form a single trunk which passed downward in a relatively normal fashion. The anterior left arch was smaller than the posterior right, and as this is usual one may expect that the defect produced on the posterior aspect of the esophagus will be somewhat smaller than that to be expected from an aorta of normal size. Occasionally, the anterior or left aortic limb is obliterated, and although constriction is likely the posterior aortic arch would be of a size similar to the normal aorta. We have not attempted angiocardiography in any of our patients but excellent visualization should be obtainable, and this method is available if the diagnosis is in doubt.

Anomalous Right Subclavian Artery. This is perhaps the most common of all of the anomalies of the great vessels at the base of the heart, but the roentgen diagnosis appears to have been reported infrequently as Copleman,[3] describing 1 case of his own, could find only 4 other cases diagnosed during life. We have made the

roentgen diagnosis in 10 cases, and 1 of these patients has been operated upon by Gross with confirmation of the preoperative diagnosis. As a rule, the anomaly produces no symptoms but occasionally severe dysphagia is produced by the pressure of the vessel on the esophagus. Dysphagia lusoria correctly refers to the difficulty produced by this anomaly and not to that produced by a right aortic arch.

When the right subclavian artery arises as the last vessel from the normal left aortic arch, it must cross the midline to its distribution on the right side. In the anatomical specimens collected by Holzapfel[13] the artery passed to the right behind the esophagus in 107 cases, between the esophagus and trachea in 20, and in front of the trachea in 6 cases. In all of our patients,

Fig. 11. J.R., infant male. Anomalous right subclavian artery arising as the last vessel from a normal aortic arch, and passing behind the esophagus to its distribution. The roentgen diagnosis was confirmed by Dr. Robert E. Gross at operation. Lateral view with barium in the esophagus shows a rounded filling defect on the posterior aspect of the esophagus. It is slightly above the level of the aortic arch and is smaller than a posterior defect produced by a posterior right aortic arch.

Fig. 12. J.R. The anomalous right subclavian as seen in the left anterior oblique projection a small oblique filling defect on the posterior aspect and the left lateral aspect of the barium-filled esophagus. The defect runs upward from left to right. Pulsations were evident, and at roentgenoscopy the normal aortic arch could be visualized.

and in those referred to by Copleman, the anomalous vessel has apparently been behind the esophagus. The roentgen picture is rather characteristic but it should not be confused with the deformity of the esophagus produced by a posterior right aortic arch. When the vessel passes from left to right behind the esophagus (Fig. 11 to 13). it produces an oblique defect that appears to be about 0.5 cm. in width. This defect passes upward from left to right on the posterior aspect of the esophagus just above the level of the aortic arch. The aortic arch can normally be seen in its usual position. On the left posterolateral aspect of the esophagus a notched defect is visible as shown in the accompanying illustrations. This defect is visualized on the right posterolateral aspect but is less prominent than on the left. The oblique defect can be readily detected in the anteroposterior

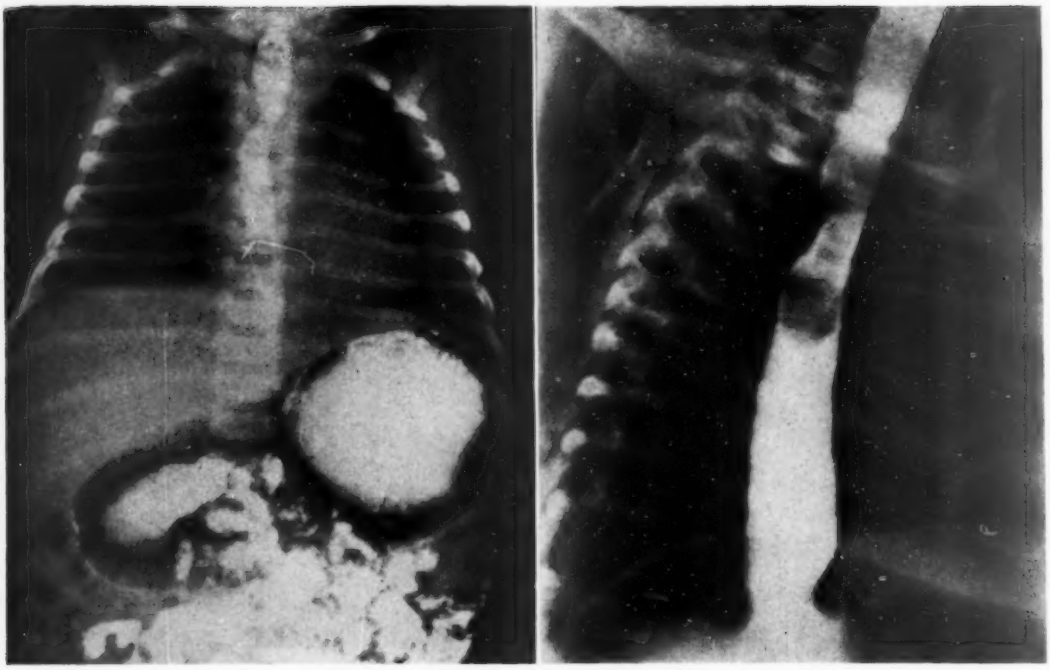

Fig. 13. D.M.G., infant female. Anomalous right subclavian artery passing behind the esophagus. Not proved as the mild dysphagia did not warrant operation. Anteroposterior and lateral veins of the chest with barium in the esophagus shows the typical oblique filling defect running upward from left to right behind the esophagus. In the anteroposterior projection the barium column shows diminution in depth as it passes over the anomalous artery.

projection if the barium swallowed is not too dense or too great in amount. When the vessel passes in front of the esophagus but behind the trachea a similar defect is produced (Fig. 14 and 15), but it is on the anterior rather than on the posterior aspect of the esophagus. The occasional vessel that passes in front of the trachea would probably produce no demonstrable defect or constriction of the trachea.

Patent Ductus Arteriosus. Careful roentgenoscopic examination will frequently lead to the correct diagnosis of patency of the ductus arteriosus, but in many instances positive findings are minimal or absent if the ductus is of small caliber.[4] If variations from the normal appearance of the heart are noted the following changes will be observed in order of frequency: (1) dilatation of the pulmonary artery; (2) cardiac enlargement; (3) enlargement of the left auricle; (4) engorgement of the intrapulmonary vessels; (5) exaggerated pulsation of the ascending aorta, pulmonary artery, and the left ventricle; (6) unusually prominent pulsation of the vessels at the hila. Steinberg, Grishman and Sussman[17] have shown that by angiocardiography it is frequently possible to demonstrate a small sacculation or "out-pouching" of the aorta at the level of the ductus. The ductus itself cannot be visualized.

Coarctation of the Aorta. The roentgenologic examination is often not diagnostic but invariably yields useful information.[7] Moderate cardiac enlargement is to be expected. The enlargement and altered contour of the heart is due to hypertrophy of the left ventricle as can be demonstrated in the right anterior oblique and posteroanterior projections. However, Perlman,[15] in reviewing 13 cases, found no evidence of enlargement of the left ventricle in 4 of his patients, and he felt that there was no

correlation between the size of the left ventricle and the degree of elevation of the blood pressure. The ascending aorta will frequently appear to be slightly dilated but the aortic "knob" is always smaller than normal and may be quite invisible. The descending limb of the aorta is usually not visualized. Accurate delineation of the constricted portion of the aorta may be obtained by angiocardiography. Notching of the inferior margin of the ribs in the posterior third is perhaps the most valuable sign but is not reliable in the early age group. We have observed definite notching at the age of eight years, and in 1 patient at nineteen months of age. Notching of the first three ribs should not be expected. The correct diagnosis can occasionally be suspected by noting enlargement of the dental pulp cavity of the deciduous or permanent maxillary incisors.[14]

In conclusion, it must be emphasized that these anomalies can no longer be considered rare. Roentgenographic studies afford the only means by which a certain diagnosis can be established. Careful roentgenographic and roentgenoscopic examination should be carried out on every patient who exhibits dysphagia, wheezing, stridor, or recurrent attacks of tracheobronchitis and pneumonia. Prompt surgical treatment should yield satisfactory relief of the disabling symptoms produced by esophageal and tracheal compression.

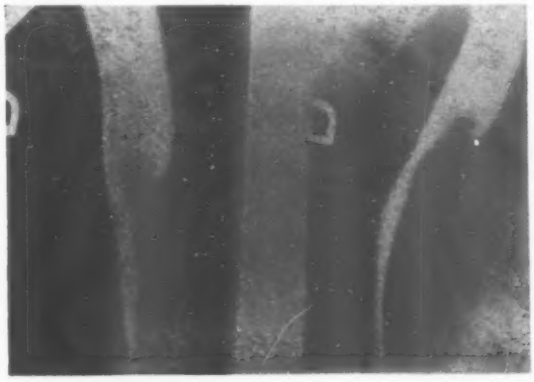

FIG. 14. Adult male with symptoms of dysphagia. Anomalous right subclavian artery arising from the normal arch and passing to its distribution between the trachea and the esophagus. Anteroposterior and lateral spot roentgenograms of the barium-filled esophagus show a small rounded oblique defect on the left lateral and anterior aspect of the barium column.

I am indebted to Drs. Copleman and Robb for permission to use Fig. 14 and 15.

FIG. 15. Same case as Figure 14. Right anterior oblique view shows the anterolateral defect just above the arch of the aorta. The deformity is essentially similar to that produced by the subclavian passing posterior to the esophagus except for its anterior position.

SUMMARY

1. Anomalies of the aortic arch are common, many are clinically significant, roentgenologically demonstrable, and amenable to surgery.

2. The nature of many of these anomalies may be determined by characteristic combination of great vessel shadows, lateral deviations of the trachea and esophagus, rounded pressure defects in the contour of the trachea, and rounded or oblique defects in the contour of the esophagus.

3. Right-sided aortic arch may be detected in the posteroanterior roentgenogram by demonstration of a right-sided aortic "knob" with deviation of the trachea to the left.

4. A right aortic arch passing posterior to the esophagus produces a rounded defect on the posterior aspect of the esophagus with deviation of the esophagus to the left. A combination of a posterior right aortic arch with a left subclavian passing from right to left behind the esophagus may produce in addition a smaller oblique defect in the posterior esophageal wall above the defect produced by the aorta. If a persistent left aortic diverticulum is present in combination with a posterior right aortic arch a double rounded defect may be observed on the posterior aspect of the esophagus.

5. A constrictive double aortic arch produces narrowing of the trachea and esophagus from both sides, anterior displacement of the trachea, and compression of the trachea as seen in the lateral projection. In both the constrictive and nonconstrictive types of double aortic arch, a rounded defect in the contour of the esophagus is present posteriorly.

6. A right subclavian artery arising from the arch of the normal aorta as the last branch of the arch may pass to its distribution on the right side in front of the trachea but will in most instances pass behind the esophagus; a characteristic small, oblique filling defect is produced. In a small percentage of cases the anomalous artery passes between the esophagus and the trachea and in such cases the typical oblique defect will be on the anterior aspect of the esophagus.

7. A summary of the roentgen findings in patent ductus arteriosus and coarctation of the aorta is presented. Two additional patients with double aortic acid have been seen since this paper was submitted for publication.

300 Longwood Ave.
Boston 15, Mass.

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ANOMALOUS RIGHT SUBCLAVIAN ARTERY ORIGINATING ON THE LEFT AS THE LAST BRANCH OF THE AORTIC ARCH*

REPORT OF A PROBABLE CASE DIAGNOSED ROENTGENOLOGICALLY

By LIEUTENANT HERBERT M. STAUFFER (MC), U.S.N.R., *and*
LIEUTENANT HARRY H. POTE (MC), U.S.N.R.

THE best known anomaly arising from variation in the developmental pattern of the aortic arch system is persistent right-sided aortic arch, a well recognized entity roentgenologically. On the other hand, origin of the right subclavian artery on the left as the last branch of the aortic arch, while not an infrequent anomaly, has been diagnosed in life by roentgenologic methods only in recent years. This small number of reported diagnoses of anomalous right subclavian artery in comparison with its relatively frequent occurrence anatomically has made it appear desirable to publish the findings in the following case, which differs in certain respects from those previously reported.

The earliest descriptions of this anomaly appeared in the first part of the eighteenth century, and by 1899 Holzapfel[9] was able to collect 193 cases from the literature. The abnormality was found in 19 of 2,291 anatomical preparations reported by eight investigators.[4] In a number of series the incidence reported has varied from 0.4 to 2.0 per cent.[12] In this connection it is interesting to note that Abbott[1] in her analysis of 1,000 cases of congenital cardiac lesions recorded only 7 examples of this condition. Kommerell[10] was apparently the first to describe the characteristic roentgen findings. His report, appearing in 1936, was based on a single case. Four further cases[6,7,12] have been reported subsequently in the European literature; 1 of these, that of Zdansky, was confirmed by postmortem study.

In the transformation of the embryonic aortic arch system toward the usual adult human pattern, the right dorsal aorta becomes interrupted caudad to the origin of the primordial right subclavian artery.[5] The subclavian artery thus takes its origin either separately as the first branch of the aortic arch or with the common carotid from the innominate (Fig. 1, *A*). The anomalous right subclavian results from interruption of the right aortic arch cephalad to the origin of the primordial right subclavian. The latter then arises from the cephalic end of the unpaired dorsal aorta and passes cephalad and to the right usually dorsad to the esophagus (Fig. 1, *B*). The anomalous subclavian thus becomes the last branch of the aortic arch. A remnant of the right aortic arch occasionally persists as a diverticulum-like or aneurysmal outpouching at the origin of the subclavian artery from the distal portion of the aortic arch.

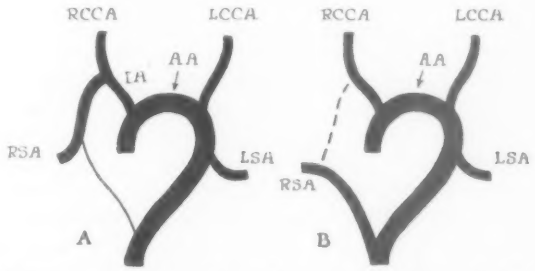

FIG. 1. *A*, diagram of usual aortic arch system in the 18 mm. human embryo (after Congdon). The right subclavian artery arises as a branch of the innominate, the caudal portion of the right dorsal aorta disappearing. *B*, development of anomalous right subclavian artery, the caudal portion of the right dorsal aorta persisting while the cephalic portion disappears (after Anson). (*AA*—aortic arch; *IA*—innominate artery; *RCCA*—right common carotid artery; *LCCA*—left common carotid artery; *RSA*—right subclavian artery; *LSA*—left subclavian artery.)

* The views expressed are those of the authors and do not necessarily reflect those of the Navy Department.

Fig. 2. Diagrammatic representation (dorsal view) of origin and course of anomalous subclavian artery in one of the earliest reported cases (photostatic reproduction of plate from Bayford's original paper). The vessel was stated to pass between trachea and esophagus; marked dysphagia was present ("dysphagia lusoria"). (*G*—ascending aorta; *H*—descending aorta; *I*—right common carotid artery; *J*—left common carotid artery; *K*—left subclavian artery; *L*—trachea; *M*—esophagus; *N* and *O*—anomalous right subclavian artery.)

The striking roentgenologic finding[11] is the presence of a small semicircular indentation (described as finger sized) in the dorsal aspect of the barium-filled esophagus at the level of the upper margin of the aortic arch. This impression is attributed to the aneurysmal origin of the anomalous subclavian artery. A soft tissue shadow representing the vessel may be identifiable and the presence of pulsations in the indentation aids in confirming the diagnosis. Kommerell states that the diagnosis can only be made roentgenologically when an aneurysmal origin of the vessel is present; this would explain the paucity of roentgenologic diagnoses of the condition recorded to date, since Holzapfel found such diverticula in only 33 of 51 cases. Dahm also and other writers are of the opinion that the possibility of demonstrating this anomaly does not exist if the subclavian in the neighborhood of the esophagus is of normal caliber. This seems even more apparent when the many variations in origin and course of the anomalous artery are taken into account. The origin is usually from the posterior wall of the aortic arch where it approaches the vertebral column and more rarely from the upper wall. If the arch swings widely to the left the origin may be from the medial wall. The angle of origin can be sharp, right, or obtuse. As the origin is always deeper than the first rib, the vessel always courses upward and to the right. According to Holzapfel, the crossing over in the midline is from C_6 to D_4. The vessel occasionally passes in front of the esophagus, between it and the trachea, and still more rarely it passes in front of the trachea. It may be noted that the anatomical specimen from Zdansky's case, which showed a well marked esophageal indentation, did not show a significant dilatation of the right subclavian at its site of origin from the aortic arch, as far as can be determined from scrutiny of the published photograph.

Caudad to the abnormal indentation of the esophagus the aortic arch impression is apt to be poorly defined. The impression due to the subclavian artery in the cases reported has been more marked in the left than in the right anterior oblique views. This again has been attributed to the position of the diverticular origin on the aortic wall. In the right oblique position the shadow of the contrast material in the esophagus may be rendered less intense just above the level of the aortic arch due to the pressure from the left by the anomalous artery. Dahm indicates that anatomical preparations suggest that compression from the right is possible in some cases. No abnormality of the great vessel contours seen in the anterior view has thus far been recorded.

The history of this anomaly is intriguing. Its early recognition anatomically led to the concept, which apparently was widely held in the early nineteenth century, that it was a frequent cause of dysphagia. Bay-

ford,[3] in an interesting paper entitled "An Account of a Singular Case of Obstructive Deglutition," published in the "Memoirs of the Medical Society of London" in 1789, presented in detail the clinical and postmortem findings. In this case dysphagia accompanied by a sense of suffocation was prominent from childhood, and the patient succumbed of inanition in her sixty-first year. Autopsy showed the right subclavian artery arising on the left and crossing to the right between the esophagus and trachea. A photostatic copy of one of Bayford's original plates is reproduced herewith (Fig. 2). For the swallowing difficulty in this case Bayford coined the term "dysphagia lusoria," a minor anomaly being referred to in his time as a "lusus Naturae," i.e., a prank of nature. The popularity of this diagnosis waned with the coming of the era of anatomic pathology but the term has persisted in connection with discussions of persistent right-sided aortic arch as well as of left-sided origin of the right subclavian artery. Dysphagia is now thought to occur in the latter condition only when the origin of the abnormal vessel is aneurysmal.

It has been suggested[2,8] that such changes as inequality of the radial pulses, enlargement of the thoracic duct, and symptoms like those in the scalenus anticus syndrome might be produced by the aberrant right subclavian artery.

Our observations relative to the great vessels were made incidentally in the course of the clinical study of a twenty-two year old male with a history of rheumatic heart disease. The patient was admitted to the hospital complaining of a pulling pain in the left side of the chest, radiating to the right shoulder, which had been present on effort since the age of fifteen years. The past history included episodes of epistaxis and wandering joint pains occurring after an attack of scarlet fever at the age of nine. From the ages of thirteen to sixteen years he had taken digitalis because of ankle edema. There had been no swallowing difficulty. Physical examination showed a robust young adult male. The blood pressure was 146 mm. Hg systolic/92 diastolic; the pulse, 92 per minute. Examination of the heart revealed a mitral presystolic thrill and murmur followed by a systolic murmur; the last, transmitted toward the axilla. An aortic systolic murmur was transmitted into the neck. The electrocardiogram showed no unusual features, and laboratory studies were negative. The liver and spleen were not enlarged, and there was no palpable peripheral lymphadenopathy.

Roentgenoscopic examination and roentgenograms of the chest revealed no cardiac enlargement, the contour of the heart proper appearing normal. However, in the anterior view a small convex prominence was evident on the left just above the shadow of the aortic knob. The latter was identifiable by the level of the indentation in the esophagus due to the aortic arch (Fig. 3). The impression was gained roentgenoscopically that this accessory shadow exhibited intrinsic systolic pulsation. On contrast visualization of the esophagus in the lateral and right anterior oblique views, a small indentation of the dorsal wall of the esophagus was evident opposite the body of the fourth thoracic vertebra and immediately above the ventral impression due to the aortic arch (Fig. 4 and 5). The abnormal notch measured 1.5 cm. in diameter on roentgenograms made with a 2 meter target-film distance. It was less well visualized in the left anterior oblique view. Pulsation could not be seen in the neighborhood of the indentation roentgenoscopically; and at esophagoscopy although the narrowing due to extrinsic pressure on the dorsal wall of the esophagus was obvious, pulsation was not observed.

The roentgen findings in this case are somewhat at variance with those in the few cases found in the literature up to the present. The indentation in the dorsal wall of the esophagus is smaller and is not best seen in the left anterior oblique view. The small convex shadow above the aortic knob on the left in the anterior view has not been described previously; in our opinion a lateral aneurysmal origin of an aberrant right subclavian artery satisfactorily accounts for this finding, and for the pulsations evident roentgenoscopically. According to our interpretation the esophageal impression in this case represents a segment of the circumference of the subclavian

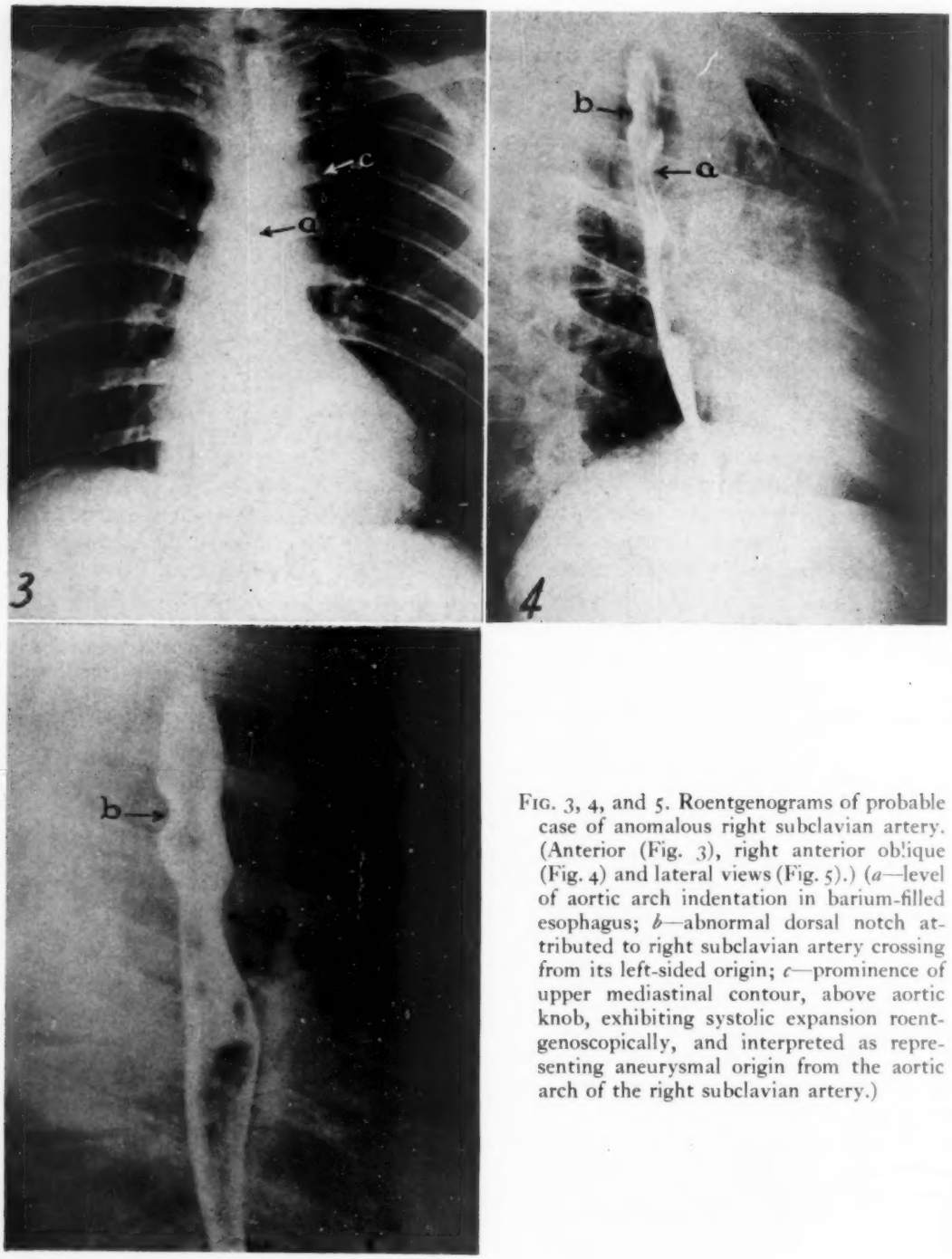

FIG. 3, 4, and 5. Roentgenograms of probable case of anomalous right subclavian artery. (Anterior (Fig. 3), right anterior oblique (Fig. 4) and lateral views (Fig. 5).) (*a*—level of aortic arch indentation in barium-filled esophagus; *b*—abnormal dorsal notch attributed to right subclavian artery crossing from its left-sided origin; *c*—prominence of upper mediastinal contour, above aortic knob, exhibiting systolic expansion roentgenoscopically, and interpreted as representing aneurysmal origin from the aortic arch of the right subclavian artery.)

artery proper, which is normal in caliber at this point due to the more lateral situation of the diverticular origin. Thus we postulate that in this case both the diverticulum-like origin and the esophageal imprint of the anomalous subclavian artery itself are recognizable. While this vascular anomaly seems to best explain the roentgen features, other possibilities obviously exist. Extrinsic compression of the esophagus by a

lymph node was not excluded since pulsations could not be identified in the indentation; peripheral lymphadenopathy, however, was absent. The possibility seems remote that a mediastinal mass, not vascular, could be responsible for both the convex contour above the aortic knob and for the esophageal imprint. It will remain for future correlated roentgen and anatomic studies to prove whether or not the findings recorded above are characteristic of certain examples of left-sided origin of the right subclavian artery.

SUMMARY

1. Case report of a left-sided origin of right subclavian artery in a young man with vague symptoms of chest discomfort.

2. The diagnosis was based on roentgenoscopic and roentgenographic findings of: (a) indentation of dorsal wall of esophagus best seen in the left anterior oblique view; (b) a small convex prominence just above the shadow of the aortic knob in the anterior view in which there appeared intrinsic systolic pulsations.

Harry H. Pote, M.D.
4032 Walnut St.
Philadelphia 4, Pa.

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SACCULAR ANEURYSM OF THE ABDOMINAL AORTA*

REPORT OF A CASE OF EIGHT YEARS' DURATION

By JOHN G. ARCHER, M.D., F.A.C.P., G. J. MARUM, M.D., *and* E. T. WHITE, M.D.
GREENVILLE, MISSISSIPPI

ANEURYSM of the abdominal aorta is about one-tenth as common as aneurysm of the first portion and the arch of the aorta. Not more than 600 cases have been reported (Hubeny and Pollack, and Scott). The disease is caused by weakening of the media by destruction of the elastic tissue. Syphilis is the most common cause but some cases are due to arteriosclerosis and infected emboli that lodge in the vasa vasorum. The disease is more common in the colored race.

Saccular aneurysm increases progressively in size, causing atrophy and erosion of any structure on which it impinges, including bony tissue. Thrombosis in successive layers occurs in the aneurysmal sac; this serves to strengthen the wall to some extent although there is but little organization of the thrombus. There is little direct effect on the heart or the circulation, and symptoms are usually due to the pressure and erosion of adjacent structures. The average time of observation of the reported cases was only a few months. Scott writes that 70 per cent succumbed within three years after onset of symptoms, that 17 per cent survived more than five years and that only 1 patient who did not have an erosion of the lumbar spine has survived for twenty-eight years.

The case we are reporting was observed for more than eight years.

P.H., white male, aged thirty-five, acquired syphilis at the age of seventeen. He had very little antiluetic treatment but had a negative blood Wassermann at the age of twenty-two. When seen in 1936 his Wassermann reaction was positive. In 1940, when an erosion of the lumbar spine was diagnosed for the first time, a brace was prescribed which enabled the patient to keep on working at rather strenuous labor—he was employed in the construction of a Trans Isthmian Highway in the Panama Canal Zone. In June, 1941, on his way back to this country, his boat was torpedoed in the Caribbean Sea. While 32 of the crew were killed the patient, bruised about his chest, made his way down the ladder and into a life boat. He was picked up after drifting two days and two nights in the life boat and returned by plane. He continued working until October, 1943, when he fell from a truck, injuring his back. He was still able to walk when he was admitted to the hospital on February 5, 1944. He died of heart failure April 18, 1944.

Clinical Course. Slowly increasing backache, at first only intermittent, later on more or less continuously, localized in the area of the lower thoracic and upper lumbar spine and radiating into both legs. A palpable mass has been felt in the epigastric area since 1940, and has gradually increased in size. The skin in the epigastric area bulged and was of bluish discoloration. Bruit and thrill could be diagnosed over the tumor. Bending and erecting of the spine has been interfered with since 1940 but the patient could turn from one side to the other until shortly before his death. There was no gibbus. The function of the gastrointestinal tract remained normal.

Physical findings on admisson to the hospital: A somewhat emaciated male, thirty-five years of age, who gave his normal weight as 165 lb.; present weight, 135 lb. Blood pressure 152/84. Fine tremor of the extended hands. Argyll Robertson pupils. Heart slightly accelerated, regular, considerable accentuation of the second pulmonic sound, loud systolic murmur at the apex. At intervals during the patient's treatment a pericardial friction rub was noted. The lungs were resonant at first but later during illness moist râles at both bases were heard. There was a palpable mass in the epigastrium over which there was a distinct bruit and thrill. Inguinal glands palpable but not markedly enlarged. The legs were at first

* From the Drs. Gamble Bros. and Archer Clinic and the Kings Daughters Hospital, Greenville, Miss.

thin but later became quite edematous. Knee jerks were slightly exaggerated.

The most impressive of the twenty-six roentgenograms taken of this patient during the time of observation are reported:

March 11, 1940 (Fig. 1): The lateral view shows an erosion on the anterior border of the first and second lumbar vertebrae, with the greatest destruction in the upper half of the body of the second lumbar.

January 6, 1942 (Fig. 2): In the anteroposterior view the opacity due to the aneurysm extends from the level of the left border of the tenth thoracic to the level of the left border of the first lumbar vertebra, bulging laterally, with its greatest width about 1 inch below the diaphragm. Distinct calcification in the upper third of the lateral wall of the aneurysm.

January 25, 1944 (Fig. 3 and 4): In the lateral view the erosion is more advanced and includes the bodies of the eleventh and twelfth thoracic and the first and second lumbar vertebrae. One-third of the eleventh thoracic, almost half of the twelfth thoracic and the first lumbar and the upper border of the second lumbar vertebrae are involved. In contrast to the increased destruction of the vertebral bodies the anteroposterior view shows that the aneurysmal sac is smaller but that the calcification of its lateral wall is complete.

Fig. 1. March 11, 1940.

Fig. 2. January 6, 1942.

April 20, 1944 (Fig. 5 and 6): The first lumbar vertebra is almost completely destroyed, showing only a smaller upper and a larger lower triangle of bone structure on its posterior border, the findings in the eleventh and twelfth thoracic vertebrae are about the same as in the examinaton of January 25, 1944, but the destruction of the second lumbar vertebra is more advanced. The appearance suggests that the aneurysm has extended backward and downward (Fig. 5).

The roentgenogram of the chest, taken in the recumbent position shows the final stage of the disease: the right diaphragm is at the level of the fourth rib, the left diaphragm at the level of the sixth rib. There is some lack of translucency of the right lung and hyperaeration of the left lung, the heart is slightly displaced to the left side. No signs of pneumonia or bronchopneumonia shortly before death. The upward displacement of the right diaphragm is due to the pressure of the aneurysm from below (Fig. 6).

Autopsy Findings. Permission to examine the abdominal cavity only was obtained. This revealed a large saccular aneurysm of the ab-

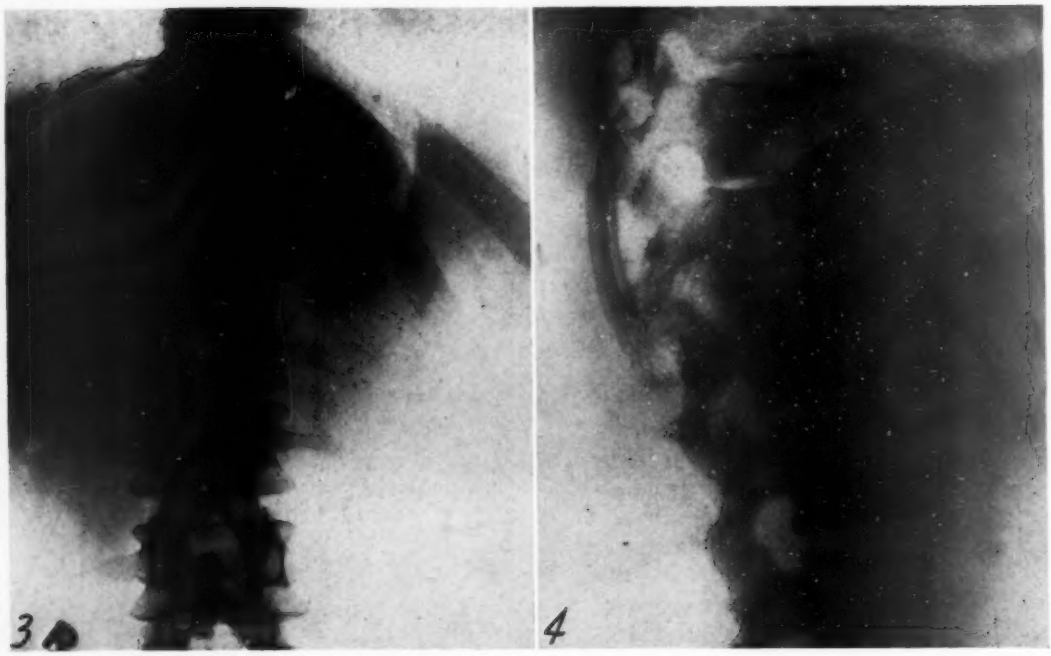

Fig. 3 and 4. January 25, 1944.

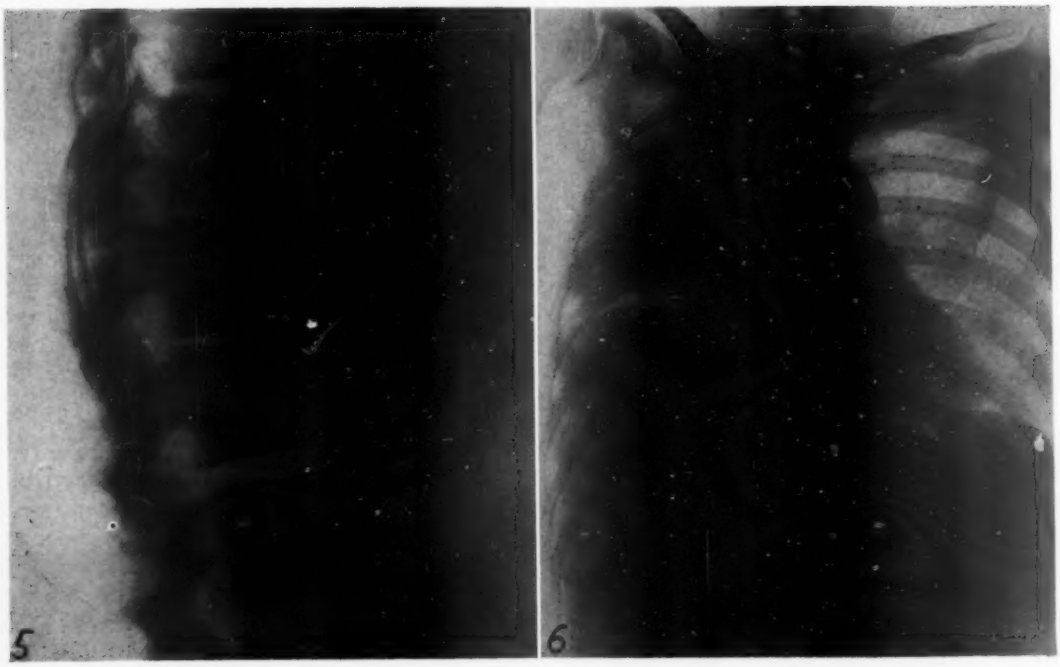

Fig. 5 and 6. April 20, 1944.

dominal aorta, 26 cm. long and 15 cm. in diameter, located in the right side of the abdominal cavity with the intestines displaced to the left side and the liver pushed up. The right diaphragm was at the level of the fourth rib, the left at the sixth rib. The sac of the aneurysm was not ruptured. There was complete erosion of the twelfth thoracic and the first lumbar vertebrae and partial erosion of the eleventh thoracic and second lumbar vertebrae. The wall of the abdominal aorta had considerable calcareous degeneration. The aneurysmal sac contained a large blood clot formed in laminated layers with practically no tendency to organization. There was considerable straw colored fluid in the abdominal cavity. The immediate cause of death was not due to the aneurysm but to congestive heart failure.

SUMMARY

A case of saccular aneurysm of the abdominal aorta, observed for eight years, is reported with clinical, roentgenological and pathological findings.

The typical roentgenographic findings were progressive erosion of four vertebral bodies and calcification of the wall of the aneurysm.

The case is of interest because the patient was able to work hard until a few months before his death and had survived torpedoing of his boat and drifting in the Caribbean Sea for two days and two nights.

We wish to thank Dr. Charles Gottlieb of New York University Medical College for having the prints of the negatives made in his department.

Medical Arts Building
Greenville, Mississippi

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HEPATODIAPHRAGMATIC INTERPOSITION OF THE COLON WITH GASTRIC HYPERTROPHY

CASE REPORT

By CAPTAIN ELI STARR
MEDICAL CORPS, ARMY OF THE UNITED STATES

OUT of 20,000 roentgenoscopies, Kolju[4] observed 29 patients with hepatodiaphragmatic interposition of the colon. Uspensky,[9] in four and a half years, observed 22 such cases from among 26,000 colon studies. From these figures, a frequency of 1.1 cases per thousand is noted. This figure is in agreement with Lusena's assertion of 1 per thousand, quoted from Felkel.[2] Felkel believes the condition to be more frequent, but usually not recognized at the bedside.

Hepatodiaphragmatic interposition of the colon is primarily a roentgenological diagnosis. It manifests itself by the presence of a collection of gas in the right subdiaphragmatic space, interposed between the densities of both the liver and diaphragm. This roentgenographic finding has become so associated with the presence of intraperitoneal air following perforation of a viscus that the roentgenologist is momentarily perplexed when he notes this condition in a patient free of symptoms, much less the clinical findings suggestive of a perforated viscus. However, hepatodiaphragmatic interposition of the colon behaves just this way. Usually, it is discovered as an incidental finding on a routine examination.[4] A case of this type is being reported. However, the main purpose of this paper is to call attention to the fact that gastric catarrh is the most common condition found associated with hepatodiaphragmatic interposition of the colon,[4] and that this catarrh is the result of gastric hypertrophy secondary to pressure of the descended liver upon both the stomach and duodenum.

Pendergrass and Kirk[5] reported a case of interposition of the hepatic flexure which upon the wet film was mistaken for free gas in the peritoneum. The diagnosis of a ruptured viscus was made. At operation, an acute pancreatitis was found. Upon the dry roentgenograms the authors noticed for the first time thin haustrations traversing the gas and revised the diagnosis. Necropsy showed the liver to be rotated and low and the hepatic flexure interposed between the diaphragm and the liver. The case illustrates how an anomalous condition may closely simulate a serious surgical entity.

Schenck[8] reported a case of a pinpoint perforation of the anterior surface of the pylorus (confirmed on laparotomy), in which the roentgenological diagnosis of a perforated viscus was rendered difficult by the concomitant existence of a hepatodiaphragmatic interposition of the colon. This latter condition was not recognized prior to operation. On reveiwing the roentgenograms, Schenck noticed and called attention to the persistence of haustral markings and the unchanged appearance of the gas in the right subphrenic space in both the erect and prone views. These findings were indicative of hepatodiaphragmatic interposition. However, the presence of a distinct fluid level in the upright views would indicate that, in addition to the meteoric hepatic flexure, there were free air and fluid in the right subphrenic space. This case illustrates how an anomalous position of a bowel loop may exist concomitantly with an acute surgical condition, rendering roentgenologic diagnosis difficult.

The cases just cited serve to illustrate the importance and need of thorough knowledge of hepatodiaphragmatic interposition of the colon. Failure to recognize this entity leads to serious embarrassment. At any rate, in no case should surgical intervention be precluded because of the

presence of interposition, particularly when clinical findings indicate immediate laparotomy. Futhermore, the article by Schenck suggests a method of differentiating free gas from hepatodiaphragmatic interposition.

In the above, the disease entity, hepatodiaphragmatic interposition of the colon, has been considered primarily as an asymptomatic incidental finding. This is not always the case. Quite a large percentage of cases exhibit varied and uncharacteristic symptoms. Felkel[2] has reviewed the literature with particular reference to the symptoms occurring in this entity and has grouped them as follows:

I. Direct symptoms: those resulting from the displacement of the colon, and

II. Indirect symptoms: those due to pressure of the descended liver upon the neighboring organs.

Constipation and flatulence are most common of the direct symptom group. These may last several days finally to be relieved by the passage of massive stools and great quantities of gas. Kolju[4] reports a case wherein a patient had only two normal bowel movements during a period of one and a half months. In the majority of the cases the constipation is of an intermittent nature. This is rather characteristic of interposition of the colon, particularly in the temporary, inconstant type of interposition of the colon (Uspensky,[9] Podkaminsky[6]). Occasionally complete obstruction results through the inability of the peristalsis to further the fecal column and so necessitating cecostomy. Thus, in every case of intestinal obstruction following chronic constipation, interposition of the colon should be ruled out.

As for the indirect symptoms, dyspepsia, pyrosis, nausea, regurgitation, and vomiting are most common. At first glance, these symptoms seem unrelated to a disease entity in which a large bowel loop is interposed between the liver and the diaphragm. However, the downward and left displacement of the liver compresses the pyloric end of the stomach and the first portion of the duodenum producing gastric retention, distention, eventual hypertrophy and possibly ulcerations. Thus, one should rather expect gastric symptoms in hepatodiaphragmatic interposition than be misled by them.

Podkaminsky[6] and Sabat-Szczepansky[7] assert that gastric ulcers appear as sequelae of interposition of the colon. This they explain on the basis of the above mentioned liver pressure upon both the pylorus and the duodenum. Also, Nicolic and Kayser,[3] in their studies of cases of ectopic livers have frequently noted gastric ulcerations associated with liver ectopy.

Yet, Bürger[1] and Weiland[10] uphold a view in direct opposition to that of the above investigators. These last mentioned maintain that the perforated gastric ulcer is the primary disease of which the intersition is a sequel. They proceed to explain that perforation of the ulcer results in an inflammatory adhesive process of the hepatoduodenal ligament which together with the weight of the ulcerated, distended stomach is sufficient to dislodge the liver from its cupola in the right cusp of the diaphragm. As a result, the hepatic flexure is permitted to interpose itself between the diaphragm and the liver.

In the above have been indicated the opposing views relative to the frequent association of interposition of the colon with gastric ulcerations. It is my opinion that both contentions are probably correct. However, the following case would favor the point of view which maintains that interposition of the colon is the primary lesion.

REPORT OF CASE

The patient, a white soldier in the early twenties, presented himself for a routine chest roentgenogram prior to his acceptance for Officers' Candidate School. On this roentgenogram (Fig. 1) large collections of gas were noted under both domes of the diaphragm. The soldier was immediately recalled for history and physical examination.

His past history revealed that he had been a lieutenant in the Polish Army during this war.

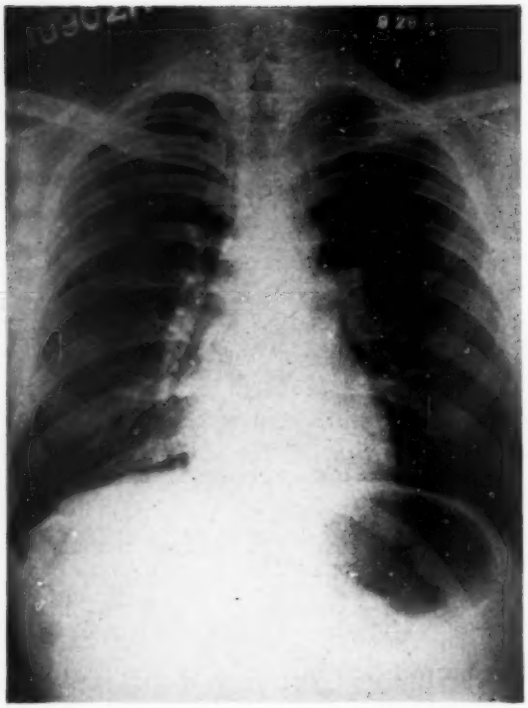

FIG. 1. Roentgenogram of the chest shows large collections of gas under both domes of the diaphragm. The gas collection on the right is out toward the periphery and it appears to be traversed by haustral markings.

FIG. 2. Barium enema, posteroanterior view, shows the distended hepatic flexure to be lateral, above, and in front of the liver. The splenic flexure is lower than usual with a large magenblase above it. The ascending and sigmoid colons are redundant.

When forced to flee to England in 1940, he had suffered severe exposure and malnutrition. He contracted pneumonia and was hospitalized in England. His condition was very critical, but he recovered after four months' treatment. As a child, he had had typhoid or typhus fever, he did not know which it was. Otherwise he had been absolutely healthy. There were no illnesses in his family.

At present, he is frequently disturbed by constipation and a feeling of being bloated. However, only on occasions does he resort to laxatives. He notes nothing peculiar about his stools. He has no abdominal pain but occasionally a sharp ache in his right shoulder. Off and on, he has a heartburn and gaseous eructations. He is able to eat all foods without discomfort. He believes that he has much more gas in his system than do other soldiers. Outside of this, he feels physically fit.

FIG. 3. Barium enema, left oblique view, shows the distended hepatic flexure beneath the right dome of the diaphragm.

On physical examination the soldier is of medium build and well nourished. The head, eyes, ears, nose, and throat are negative. The chest examination shows the lungs and heart to be within normal limits. His abdomen is dome shaped, nontender, and tympanitic throughout. The liver and spleen are nonpalpable. No masses can be felt in the abdomen. One medical officer believes the abdominal cutaneous vessels to be prominent. There are no musculoskeletal abnormalities.

Roentgenoscopic and roentgenographic examination of the colon by barium clysma showed the hepatic flexure to be markedly distended and to lie above and in front of the liver, beneath the lateral half of the right dome of the diaphragm. The uppermost portion of the ascending colon was similarly dilated and lateral to the liver shadow. From this unusually high position, the hepatic flexure dipped abruptly downward to become continuous with the transverse colon. (According to Felkel,[2] the falciform ligament is the cause of this abrupt change in course.) The splenic flexure was at a much lower level than the hepatic flexure, beneath a rather large magenblase. This large gastric air bubble may have caused the caudal displacement of the splenic flexure. Both the ascending and sigmoid colons were elongated and redundant but neither exhibited the degree of distention seen in the hepatic flexure. The remainder of the large bowel was characterized by moderate distention and an enormous capacity for contrast medium, almost three times the normal amount (Fig. 2, 3, 4, and 5). Upon the evacuation roentgenogram the large bowel was meteoric. The excursions of both domes of the diaphragm were equal.

Fig. 4. Barium enema, right oblique view, shows the distended hepatic flexure beneath the outermost portion of the right dome of the diaphragm. Note the large magenblase.

Fig. 5. Barium enema, post-evacuation roentgenogram, shows the meteoric hepatic flexure.

The presence of the unusually large gastric air bubble on many of the roentgenograms suggested either an abnormality of the stomach itself or gastric dilatation, probably secondary to liver pressure upon the pylorus and duodenum. Roentgenological examination of the stomach and duodenum showed extrinsic pressure upon the lesser curvatures of both the stomach and duodenal cap, confirming liver ectopy (Fig. 6 and 7). Both the stomach and cap were markedly elongated and dilated. The mucosal folds were hypertrophic and the peristalsis quite active. From many of the roentgenograms the impression was gained that the liver was somewhat smaller than normal.

Fig. 6. Roentgenogram shows distention and hypertrophy of both the stomach and the duodenal cap.

Fig. 7. Roentgenogram shows pressure along the lesser curvatures of both the stomach and duodenal cap.

SUMMARY AND CONCLUSION

Hepatodiaphragmatic interposition of the colon is not a rare entity, and thus it attains sufficient importance so that its symptomatology, course, complications, differential diagnosis and treatment be gone into with greater thoroughness. Heretofore, investigators have concerned themselves primarily with its etiology and with the reporting of the entity as a rare and incidental finding. The author has included two case reports from the literature to illustrate how real and important the need for thorough familiarity with this entity can be. Next, the gastric symptoms, often found associated with hepatodiaphragmatic interposition, are elaborated upon. A special point is made of stressing the logical association between interposition of the colon and the presence of these gastric findings. The case herein reported is illustrative inasmuch as it demonstrates hepatic pressure upon a hypertrophic stomach.

98 Heyward St.,
Brooklyn 6, N. Y.

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MYELOGRAPHY IN PATIENTS WITH RUPTURED CERVICAL INTERVERTEBRAL DISCS*

By LIEUTENANT COLONEL FRANCIS MURPHEY, LIEUTENANT COLONEL LUCIEN M. PASCUCCI, MAJOR WILLIAM H. MEADE, *and* CAPTAIN BENJAMIN R. VAN ZWALUWENBURG

MEDICAL CORPS, ARMY OF THE UNITED STATES

WITHIN the past two decades, myelography employing an opaque medium, has become a standard and well recognized roentgenographic procedure in the examination of the spinal canal. More recently, it has been established[1] that lateral rupture of the cervical intervertebral discs producing pain in the neck, shoulder and arm is a fairly common lesion. It is the purpose of this paper to present our experience with pantopaque myelography in patients having or suspected of having this condition.

Considerable diversity of opinion still exists in regard to the accuracy, or even the necessity of myelography in the diagnosis of ruptured disc in the cervical region. It is apparent that this question will remain unsolved until a large series of patients are subjected to both myelography and exploration, irrespective of the findings with myelography. To our knowledge such a series has not been reported as yet. However, it may safely be stated that with reference to the lumbar spinal canal, it is not an uncommon experience to obtain a negative myelogram in a patient who has all the signs and symptoms of a ruptured intervertebral disc. Furthermore, when these patients are explored a definite herniated nucleus has often been found. We have in our series of lumbar myelographies a sufficient number of such instances to justify the conclusion that a negative lumbar myelogram is merely inconclusive and does not rule out the presence of a herniated nucleus pulposus.

There is little literature on the subject of myelography in the diagnosis of ruptured discs in the cervical region. Spurling and Scoville[2] were the first to report a significant series of cases. They concluded that myelography is an exceedingly accurate method of diagnosing these lesions and cited 11 cases proved at operation with only 1 normal myelogram in the group. Unfortunately, no mention was made as to whether there were any negative explorations in patients in whom a defect had been visualized in the myelogram. Michelsen and Mixter[3] reported 8 cases of rupture of cervical discs, 7 of which had had myelography. In 1, the myelogram was negative; in 2 it was unsatisfactory; and in 4, the results were only suggestive. No conclusions concerning the accuracy of this procedure were offered. Epstein and Davidoff[4] reported 5 cases of ruptured cervical intervertebral discs, in all of which the herniated nucleus pulposus produced spinal cord symptoms of varying degree. These lesions are usually much larger than those producing nerve root pressure alone; they are located in the center or at least near the central portion of the canal and result in myelographic defects differing from those that are the subject of our paper. Browder and Watson[5] have recently reported on a series of 21 operated cases with an excellent clinicopathologic study. Their cases have included disturbances of the disc causing pressure on the nerve root and/or spinal cord. They state that they had been able to collect only 69 verified cases. Our experience is based on 62 cervical myelograms, 28 of which were positive, with 16 verified at operation.

Lateral herniation of the cervical intervertebral disc may result from slight or severe trauma or it may appear without any recognizable injury. These lesions have been classified into two types: the soft ex-

* From the Departments of Neurosurgery and Radiology of the O'Reilly General Hospital, Springfield, Missouri.

truded nodule of nucleus pulposus which may later undergo degeneration and calcification and when calcified is often wrongly interpreted as an arthritic spur; and protrusions of the disc without rupture of the annulus fibrosus or extrusion of the nucleus. Calcification may occur in the late stage of this second type also.

The symptoms vary greatly in intensity. Usually there is some pain and stiffness in the neck with radiation down the medial border of the scapula, the shoulder, the anterior chest, the lateral and medial borders of the arm and forearm to the hand. Weakness of the hand and numbness and paresthesia in the thumb or one or more fingers may be present. As in the patient with rupture of a lumbar intervertebral disc, straining, coughing and sneezing aggravate the pain. Examination reveals muscle spasm and limitation of motion of the neck. There is some degree of scoliosis of the cervical spine, usually away from the lesion. Tenderness over the brachial plexus and scalenus anticus muscles may be elicited. Pressure on top of the head, described by Spurling and Scoville,[2] reproduces the pain. This may be accomplished also by pressure over the emerging nerve root. Motor, sensory and reflex changes may be present in the arm.

Actually in most cases the clinical findings permit of a high degree of accuracy in the localization of the lesion. In a significant number of cases, however, there are no findings upon which to base a neurologic localization.

The spinal fluid examination is of relatively little value in diagnosis of lateral herniations. Occasionally, however, there may be an increase in the total protein content.

The indications for cervical myelography in ruptured intervertebral discs are not yet clear. At the O'Reilly General Hospital, it has been our policy since late 1943 to do myelograms upon all cases suspected of having a ruptured cervical disc, provided that severe enough symptoms and signs have been present to warrant operation or if an exact diagnosis was necessary for other reasons. This latter group has included several patients diagnosed as having coronary artery disease. In addition, the following are being subjected to myelography: all patients with the so-called scalenus anticus syndrome; patients with radiating pain in the arm associated with cervical rib; patients who have paralysis in an upper extremity due to involvement of one or more nerve roots; and those with indeterminate radiating pain in an upper extremity. It is freely admitted that in many cases, particularly those with the typical syndrome, myelography was not necessary to determine either the presence or localization of a ruptured disc. Yet, an occasional patient may show a ruptured disc which is impossible to demonstrate by any other method.

TECHNIQUE

We consider pantopaque (ethyl iodophenylundecylate) to be the opaque medium of choice. At body temperature it is one-seventeenth as viscid as the iodized poppy seed oils. For this reason it is more easily injected and removed, is less prone to globulation and, most important, it assumes more accurately the shape of the subarachnoid space. It has a further advantage in that any portion which cannot be aspirated will be absorbed. Its more rapid movement has not proved a disadvantage in either the lumbar or cervical regions because in both of these regions the spinal curve in the prone patient is concave upward and motion of the oil can be exactly controlled by the degree and speed of table tilt. (In the dorsal region, which is concave downward, the amount and rapidity of flow cannot be thus well controlled and a more viscid medium might therefore be more desirable for dorsal myelography.)

The injection is made with aseptic technique. The operator is dressed as for any surgical procedure, wearing cap, mask, sterile gown and sterile gloves. The roentgenologist, technicians and patient wear masks. With the patient lying on his side

the spinal puncture is performed between the fifth lumbar and first sacral segments. Some prefer the third or fourth lumbar interspace. When a free flow of fluid has been obtained the patient slowly straightens out his legs and turns over into the prone position. He is draped with a perforated spinal puncture sheet and manometric studies are done to demonstrate by free rise and fall of fluid on cough and Queckenstedt maneuver that a satisfactory tap has been obtained. If a free motion of fluid in the manometer cannot be obtained by manipulation of the needle a preliminary injection of 1 cc. of opaque medium is done and its movement on coughing and on tilting the table is studied roentgenoscopically to confirm its subarachnoid location before the remainder of pantopaque is injected. This precaution is taken to avoid the difficulties which occur in trying to obtain a satisfactory tap and satisfactory roentgenoscopic visualization after a substantial epidural injection has inadvertently been made. If blood is obtained in the subarachnoid space the procedure is delayed ten days. (In one instance an accidental intravenous injection was made in this hospital; the patient did not develop any untoward symptoms.)

After confirming the establishment of a satisfactory tap either by manometric studies or by the observation of a small preliminary injection, the operator completes the injection of 6 cc. of opaque material. This is done with the table tilted as much as may be necessary to bring the tip of the needle to the lowest point of the lumbar curve. This insures that the opaque material will directly enter a pool as it leaves the needle, rather than becoming globulated by descending in a series of drops from the needle tip to a pool some distance cephalad or caudad.

For cervical myelography the patient's head is placed toward the end of the table which can be tilted the lowest and the body supported by a shoulder rest. The patient's neck is hyperextended so that the face is looking directly forward. A thickly folded sheet is placed under the chin to maintain this position during the initial procedure of tilting the table until the oil has shifted to the cervical region. The table tilt is increased slowly until the oil begins to spill over the dorsal curve and run into the cervical region. The first entry of the oil into the cervical area is often very informative and is closely observed. After all the oil has entered the cervical region the table is brought back nearly to the horizontal. From this point on an extreme table tilt will not be necessary and there is therefore less danger of flow of oil into the intracranial cisterns from which it cannot always be recovered. The marked hyperextension of the neck is therefore no longer necessary and is reduced in order to remove as far as possible, the shadow of the occiput on the upper cervical spine.

Roentgenoscopic examination is then made in the frontal position while the table is varied to bring the oil into the various levels of the neck. The fourth cervical to first dorsal levels are checked with special care as they include the frequent sites of nucleus pulposus protrusion. The contour of the column is observed when each region is filled with opaque medium. The behavior of the oil as it enters and leaves the region is also closely studied as the minimal recognizable lesions will be indicated only by a delay in flow or deviation in the direction of flow of the entering or exiting oil and by a thinness, demonstrable only when the region is partially filled, of the oily layer over the lesion.

Pertinent exposures are made with spot film apparatus in frontal and oblique positions, since occasionally defects can be detected in the oblique views which do not show in the anteroposterior projection. This is particularly true of small central lesions. Roentgenoscopy and roentgenography in the lateral projection have not, in our experience, added any information. The films are developed immediately and studied in conjunction with the roentgenoscopy until a satisfactory study of all suspected abnormalities has been made.

The examination is then complete. In order to return the oil to the lumbar region it is necessary to reverse the patient on the table so that the feet will be at the end which descends lowest. The patient's head is manually supported in moderate hyperextension while this maneuver is done. With the table tilted to a nearly upright position the patient coughs and turns his head several times to dislodge as much oil from the nerve root sheaths as possible. The table is then returned toward the horizontal until the oil rests beneath the needle when it is aspirated. Some difficulty may be experienced in obtaining the last 0.5 cc. of oil, but with rotation of the patient and change of level of the opaque medium under roentgenoscopic control this can nearly always be accomplished. The needle is withdrawn and the patient returned to the ward where he is kept flat in bed for forty-eight hours to minimize headache. During this period 1 gram of sulfadiazine and 2 grams of sodium bicarbonate are given every four hours.

It has been noted that approximately 5 per cent of the patients develop some stiffness of the neck after myelography and this may last for seventy-two hours. However, with one exception, this has not been an indication of infection. It is probably associated with an inflammatory response of the meninges due to the slight irritative effect of the opaque medium.

ROENTGENOLOGIC INTERPRETATION

The importance of preliminary examination of the cervical spine cannot be too greatly stressed; when the findings on this examination are correlated with the clinical history they are quite significant. Positive findings appear to be proportionately more frequent in this portion of the spinal column than in the lumbar; this we believe to be due to the anatomical differences present. To detect abnormalities it may be necessary to expose films in anteroposterior, lateral and stereoscopic oblique projections. However, it must be noted that a ruptured cervical disc may be present and produce severe symptoms without demonstrable abnormality on the plain roentgenograms.

The changes on the plain roentgenograms were first described by Semmes and Murphey.[1] The following abnormalities should be looked for: (*a*) scoliosis; (*b*) straightening or reversal of normal cervical curve, either complete or segmental; (*c*) calcification in the posterior joint space; (*d*) encroachment of the intervertebral foramen by soft tissue shadow and/or osteophyte; (*e*) localized arthrosis.

The frequency of the occurrence of changes on the plain roentgenograms is illustrated in Table 1, which shows that for our series 18, or 69 per cent, of 26 patients with a disc on roentgen examination had a reversed or straightened curvature. For those without a disc the corresponding percentage is 30. The higher incidence in the former is apparent.

TABLE I

CERVICAL MYELOGRAPHY

(January 1, 1943–July 1, 1945)

	Number	Per Cent
Myelograms	62	
Positive for disc	28	45
Plain films taken	26	
Abnormality on plain films	23	88
Reverse or straightened curvature	18	69
Negative for disc	34	55
Plain films taken	31	
Abnormality on plain films	16*	52
Reverse or straightened curvature	9	30

* Includes 4 patients with fusion, 2 with arthrosis and 1 with old compression fracture.

So that these figures may not be misleading it should be stated here that there are many other conditions of the cervical spine which can cause an abnormal curvature and which are far more common. Among these are injuries such as sprains and partial dislocations to which this segment of the spinal column is particularly susceptible. Nerve root irritation due to causes other

than pressure from a herniated nucleus is also far more frequent. The point to be made s that the finding of an abnormal curvature should lead one to suspect the presence of a ruptured disc.

It may be of value at this point to digress and discuss the relationship of localized hypertrophic arthritis (arthrosis) in the cervical spine to ruptured cervical discs. Roentgenologists have for many years described these lesions. Their interpretation, however, has not always been correct. It is our opinion that these changes in a significant number of cases are the result of injury to the disc, thereby constituting a traumatic rather than hypertrophic or degenerative arthritis. This opinion is supported by the work of Keyes and Compere[6] who have proved experimentally that injury to the intervertebral disc is followed by spur formation along the margins of the adjacent vertebral bodies. Localized spur formation is more common in the two divisions of the spinal column subject to the greatest stress, namely the lower cervical and the lower lumbar areas. It is not merely a coincidence that these sites are likewise the location of the great majority of ruptured discs. In addition, herniated nucleus pulposus material has been found in the center of these so-called hard nodules or arthritic spurs. One of us (F. M.) has also seen spurs develop on the vertebra adjacent to the ruptured disc in the cervical and lumbar regions both before and after operation. Oppenheimer[7] states that disc rupture and Hadley[8] believes that narrowing of the joint space (which no doubt occurs sooner or later in most herniations of nucleus) are factors in the production of localized arthrosis.

Although preliminary roentgen examination gives adequate information about the intervertebral joint space, from a roentgenologic standpoint the myelogram is in most cases necessary in demonstrating the presence of protrusion or herniation of the nucleus pulposus. In myelography, roentgenoscopic and roentgenographic observation are of equal importance. Deviation in direction of flow and delay are purely roentgenoscopic findings while filling defects of the subarachnoid space are visualized both on roentgenoscopy and on the roentgenogram.

When the lesion is situated laterally the defect is triangular with a distinct lower border; more often, however, it is hemispherical. It is usually located at the level of the joint and is occasionally best seen with the occiput rotated toward the side opposite the lesion. The cuff of the nerve root pouch may be blunted or entirely obliterated. Occasionally it may be displaced caudally, resulting in a change in the angle of exit of the nerve. One may rarely find a widening of the caliber of the nerve root which is interpreted as edema. Just as infrequently one finds a large unilateral lesion which is exerting pressure on the subarachnoid portion of the subjacent cervical nerve root displacing it medially.

The midline lesions are visualized by a round or irregular "gap" defect at the level of the joint and are best seen in the frontal projection with only partial filling of the level at which they are situated. At roentgenoscopy it is this lesion which may first become apparent as a transluscency of the central portion of the column of opaque medium. In the larger central lesion the column of opaque medium assumes a "U" or "L" configuration as it flows past the obstruction. This is the type of lesion which is most apt to cause greatest damage to the spinal cord although the lateral lesion if large enough will also compress the cord.

In the interpretation of the myelograms it has been wiser to describe the abnormality as a defect. One can on occasions differentiate between protrusion of the disc and herniation of the nucleus pulposus but it is felt that this differentiation can only be made with certainty at operation. Likewise it is hazardous to differentiate a hard from a soft lesion unless calcium in the foramen is conclusively visualized. The defect may be small or large, smooth or irregular. It may be well defined or poorly circumscribed as in those large lesions causing

compression of the spinal cord. Four types of lesions were most common roentgenographically in this series:

1. The shallow "half-moon" defect with an irregular or smooth base. The nerve root may be broadened or it may be entirely obliterated. Occasionally either the superies or the inferior cuff may be effaced.

2. The triangular-shaped defect with a clear-cut lower border and less distinct upper border. The root sleeve is usually obliterated.

3. The poorly circumscribed "pressure" defect due to compression of the spinal cord with obliteration of the nerve root. This defect may be large or small.

4. The large irregular "gap" defect sometimes extending to the midline. The nerve root is deformed or obliterated and there is a narrowing of the lateral column of dye.

CORRELATION OF ROENTGENOGRAPHIC AND OPERATIVE FINDINGS

It has been stated above that an accurate clinical diagnosis of a ruptured disc can be made in a large percentage of patients without recourse to myelography. It would be desirable to know just how accurate myelography is in those patients where the clinical diagnosis is obscure or uncertain. Again this could only be answered by exploration of all patients having undergone myelography irrespective of the myelographic finding. Here, it can be affirmed without reservation that in our series a perfect correlation existed in that a herniation or protrusion was found in every patient operated upon because of nerve root pressure and positive myelographic findings. In addition, 3 other patients suspected of having a disc clinically but with negative myelograms were explored without finding a disturbance of the disc (Table II). It must again be emphasized that this high degree of accuracy in roentgen diagnosis was possible only by correlating the clinical findings with the myelographic result. Several patients had multiple defects but no attempt was made to confirm them at operation unless there was clinical evidence of pressure on the nerve root. Since not all patients in this series having negative myelograms were operated upon, the diagnostic value of the negative myelogram has not been completely determined; yet it seems justifiable to conclude from the evidence thus far that the negative cervical myelogram bears more weight than the negative lumbar myelogram.

TABLE II

	Myelogram positive	Myelogram negative
Operation with positive results	17*	0
Operation with negative results	0	3
No operation	11	31
Total	28	34

* Includes one recurrence.

DISTRIBUTION OF LESIONS OBSERVED MYELOGRAPHICALLY

While it has not been possible to confirm by operation the presence of all defects described on roentgen examination it would

TABLE III

	Cases	Per Cent
A. Side		
Right	21	56
Left	17	44
Total	38	100
B. Level		
C-3	2	5
C-4	1	2
C-5	12	32
C-6	21	56
C-7	2	5
Total	38	100
C. Number of lesions per patient		
Single lesion	18	66
Bilateral at one level	5	19
Multiple levels	5	15
Total	27	100

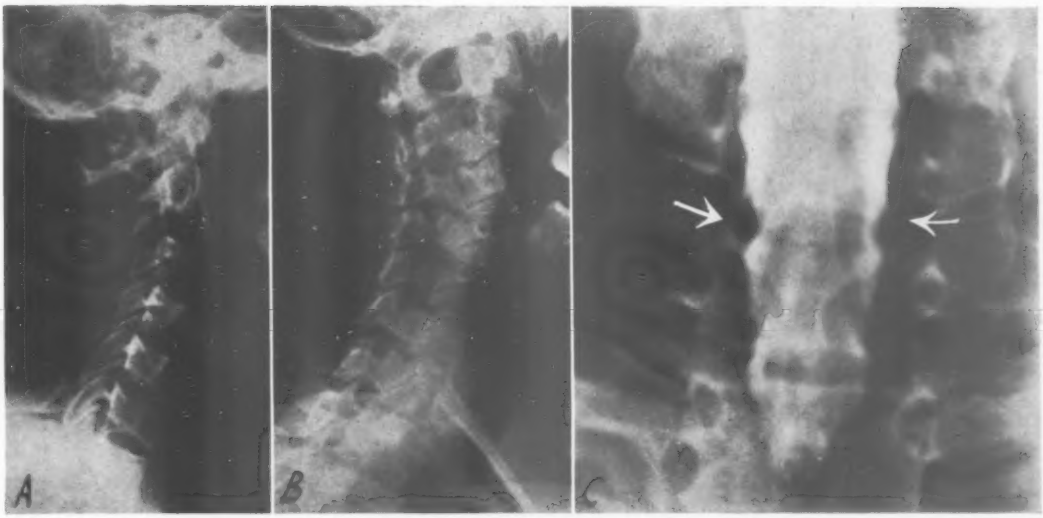

Fig. 1. Case 1. (*A*) straightening of cervical curve in lower half, narrowing and posterior spurring of joint space between C-6 and C-7. (*B*) encroachment of foramina on left at levels of C-4, C-5 and C-6. (*C*) bilateral shallow smooth defect at C-6 with flattening of root sleeves.

still be of interest to tabulate the distribution of the lesions in our series. The accuracy of any series of course would be higher, the fewer the examiners and the greater their experience. It is evident in Table III that there is a preponderance of single lesions (66 per cent); that they are fairly evenly divided between the right and left sides and that the most frequent sites are at the levels of the sixth cervical and the fifth cervical (88 per cent). The latter finding confirms the observation that the lower cervical spine is the point of greatest stress so much so that it has been described as the handle of a whip.

ILLUSTRATIVE CASE REPORTS

Case 1. An Army nurse, aged twenty-two, on May 30, 1944, began to have pain in the left shoulder which radiated along the outer aspect of the arm, forearm and into index and middle fingers of the left hand. Physical therapy in the out-patient department giving no relief, she was hospitalized in June, 1944. Past history shows that she was thrown from a horse in childhood and had a stiff neck for two weeks. On physical examination there was marked tenderness over the scalenus anticus muscle at the level of the sixth transverse process, decrease in the left triceps reflex and hypesthesia in the left index and middle fingers. Roentgen findings are shown in Figure 1, *A*, *B*, and *C*. A left subtotal hemilaminectomy was done and a protrusion of the disc without rupture was noted at the level of C-6. The seventh cervical root was decompressed. Following operation the patient had a complete relief of symptoms.

Case II. A soldier, aged twenty-seven, in March, 1944, while doing calisthenics developed pain in the posterior neck associated with a shock-like tingling in the whole body. Stiffness in all extremities and pain in the left elbow were also noted. He was transferred from a station hospital to O'Reilly General Hospital with a diagnosis of cord tumor. On physical examination there was a mild spasticity of the upper and lower extremities, diminution of deep sensibility, and diminished vibratory sense. Reflexes were increased. A lumbar puncture showed partial block and increased protein. Roentgen findings are shown in Figure 2, *A*, *B*, and *C*. A laminectomy was done from C-3 to C-6 and many fragments of herniated nucleus pulposus were removed. There was a disappearance of the pain in the left upper extremity and gradual improvement in the quadriplegia.

Case III. An officer, aged thirty-four, in July, 1942, while overseas, noted an occasional sharp stabbing pain at the base of the neck with radiation under the right scapula. On Decem-

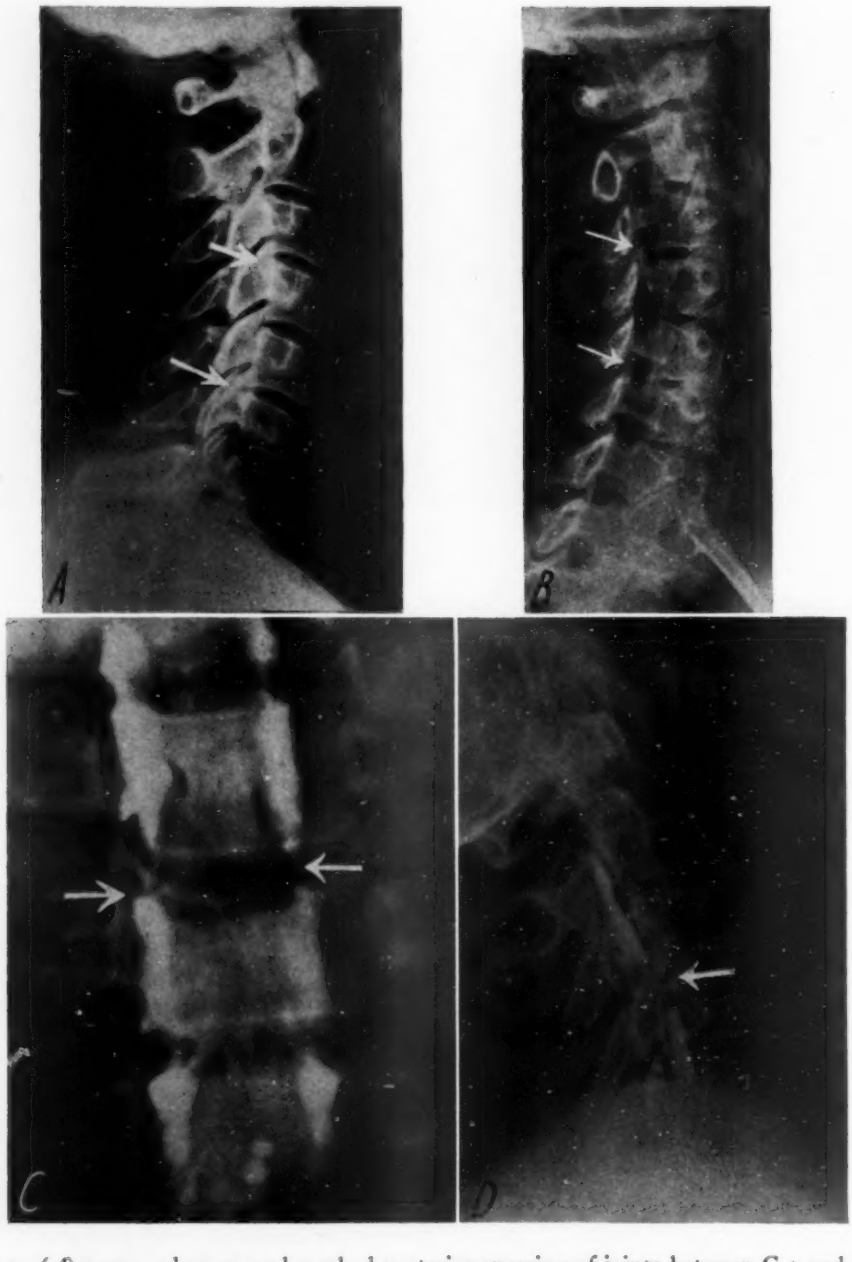

FIG. 2. Case 11. (*A*) narrowed space and marked posterior spurring of joints between C-3 and C-4 and C-5 and C-6. (*B*) encroachment of foramina at C-3 and C-5, left. (*C*) bilateral shallow irregular defect at C-5, with widening of root cuff. (*D*) block in column of dye at C-3.

ber 25, 1942, he awakened with a stiff neck. Physical therapy seem to alleviate the pain and he continued on duty until February, 1943, when he developed a burning pain in the right side of his neck. A brachial plexus block with procaine was done without relief. He was then sent back to the United States. On arrival the pain radiated down the outer right forearm and into the thumb and index finger. Coughing, sneezing and straining aggravated this pain. At one general hospital the spines at C-7 and T-1 were removed without relief, but subsequent bed rest improved his symptoms. In October, 1943, he had a recurrence and was transferred

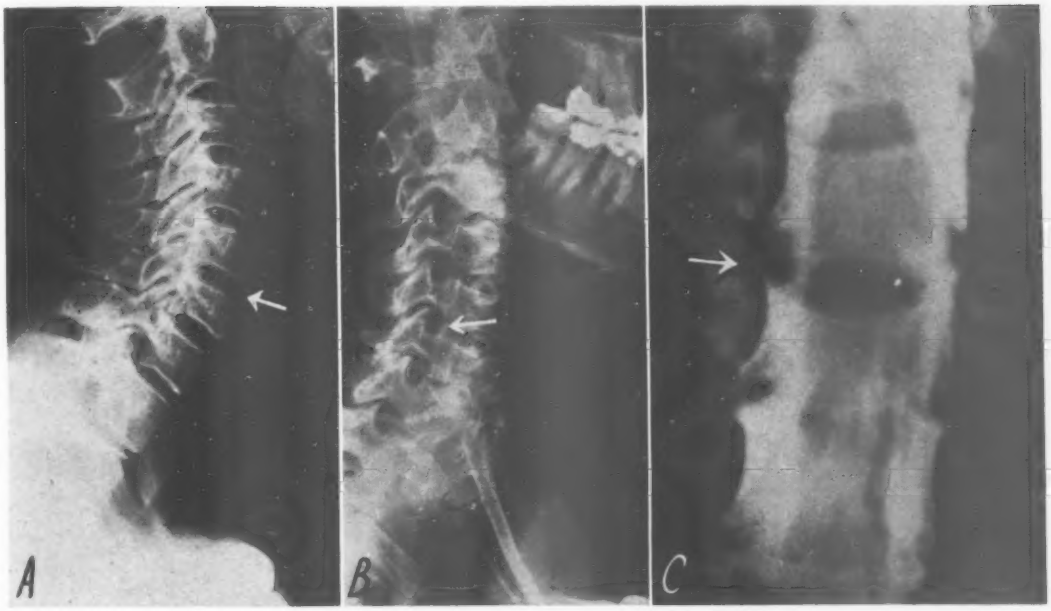

Fig. 3. Case III. (*A*) posterior spur formation especially marked between C-5 and C-6. No loss of curvature. (*B*) encroachment of foramen on right between C-5 and C-6. (*C*) small shallow irregular "half-moon" defect impinging on nerve root at C-5 on right.

to O'Reilly General Hospital. On physical examination there was a midline scar over the lower cervical and upper thoracic regions. There was percussion tenderness over C-6; rotation and compression of the neck reproduced this pain. The right biceps jerk was decreased. Roentgen findings are shown in Figure 3, *A*, *B*, and *C*. Patient refused surgery; treatment in the form of traction, physical therapy and bed rest was given. There was no improvement but the officer returned to duty, and still continues to have the same symptoms though less severe.

Case IV. A soldier, aged twenty-five, on November 12, 1943, received a gunshot wound of the right leg, which was treated in a general hospital in Australia. While under treatment the patient developed "smothering" spells which were associated with a const icting sensation in left lower chest. He also had some left arm and forearm pain. After transfer to the O'Reilly General Hospital and while on furlough his condition was aggravated. The neuropsychiatric consultant felt that although an anxiety state existed there was an organic basis for his difficulty. On physical examination there were no significant findings but the history suggested a herniated disc as all other laboratory tests and electrocardiogram were negative. Roentgen findings are shown in Figure 4, *A* and *B*. Treatment was conservative with reassurance as to the heart. Signs and symptoms were too mild to justify surgery. Improvement resulted.

Case V. An officer, aged thirty-five, in February, 1944, was carrying an 80 pound pack on his back and pulling a sled for a period of thirty-six hours when he developed a pain in the right shoulder, inner side of arm and forearm and a blanching of his ring and little fingers. Novocaine was injected in the brachial plexus region with marked relief. However, arm and forearm ache persisted for four months. In July, 1944, he had severe recurrence and was given thiamin chloride and heat without relief. In December, 1944, a private physician found a narrowed joint space between C-6 and C-7. In late December left upper extremity pain appeared after the pain on the right had ceased. This new pain was associated with a stiff neck and was aggravated by coughing and sneezing. He was admitted to the O'Reilly General Hospital with a diagnosis of brachial neuritis. On physical examination there was marked spasm of the left neck muscles with elevation of the

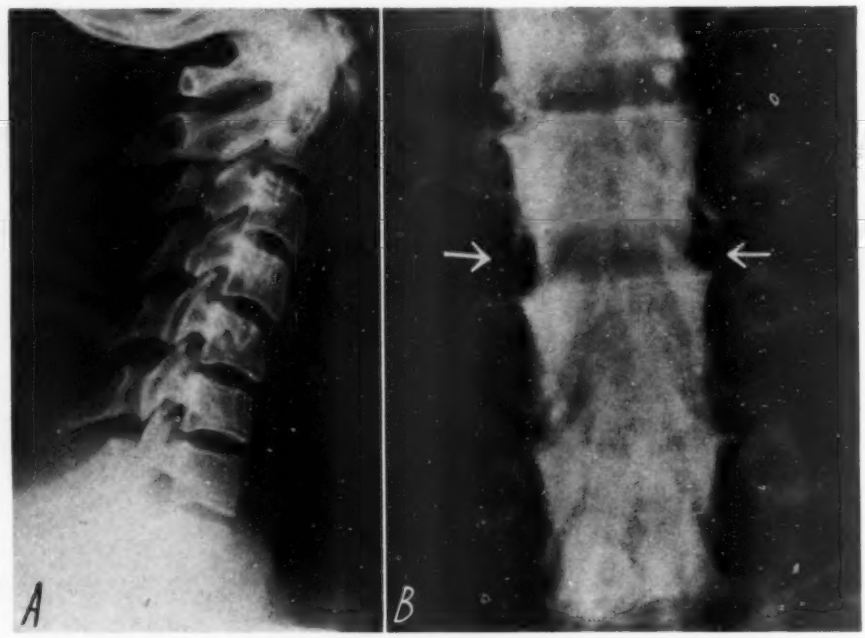

FIG. 4. Case IV. (*A*) reversal of normal anterior curve. (*B*) bilateral minimal smooth defect between C-6 and C-7 segments.

shoulder. Pressure on the head and rotation of the neck reproduced the pain. Rotation of the neck and flexion was limited and the left biceps jerk was reduced. Roentgen findings are shown in Figure 5, *A*, *B* and *C*. A subtotal laminectomy between C-6 and C-7 on the left was done with removal of a herniated nucleus pulposus. The pain and muscle spasm were relieved. The

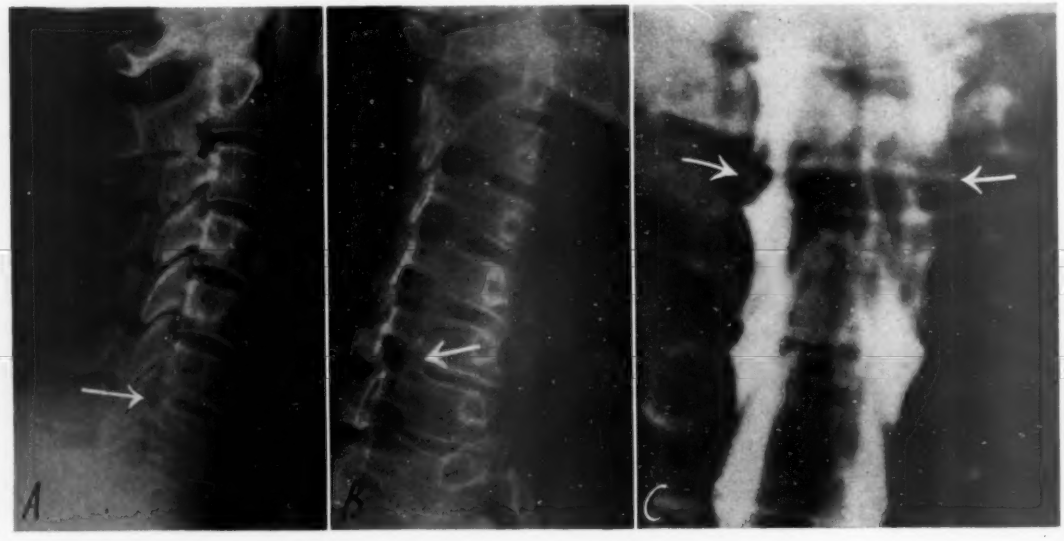

FIG. 5. Case V. (*A*) straightening of lower cervical spine; narrowed space and posterior spurring of joint space between C-6 and C-7. (*B*) encroachment of foramen between C-6 and C-7 on left. (*C*) bilateral shallow irregular defect more marked on left and obliterating nerve root at level of C-6. Edema of spinal portion of subjacent nerve root.

left shoulder assumed a normal posture, about two months after surgery. However, three months after surgery patient developed some precordial pain and a hot spot under left scapula, which was relieved by traction; this may be a recurrence.

Case vi. An officer, aged thirty-five, in August, 1944, developed pain in the right shoulder with radiation down the outer aspect of the arm and dorsal aspect of forearm, lasting one week. In October, 1944, patient developed a stiff neck followed by a recurrence of the above arm and forearm pain. He went on leave, took a 2,000 grams showed that the previously noted calcification in the foramen had been removed.

Case vii. A soldier, aged thirty-five, while lifting a heavy piano in January, 1945, suddenly felt a pain in the base of his neck. Within two days he had radiation of the pain in his left shoulder, the outer side of the left arm, forearm and into the index and middle fingers. Rather marked precordial pain was also present intermittently; this concerned him the most. He received conservative therapy in the form of heat and massage without any relief of symptoms and was eventually transferred to O'Reilly Gen-

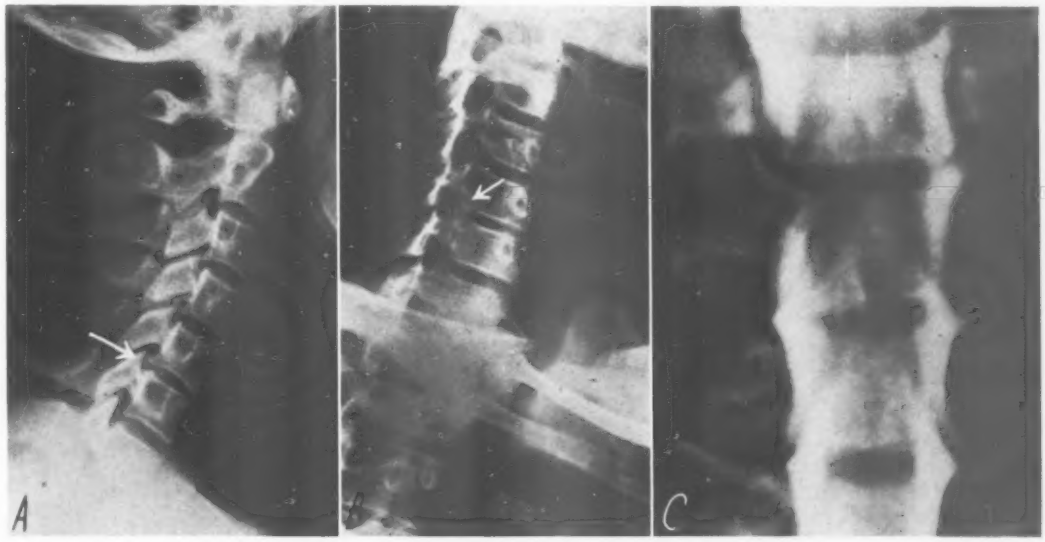

Fig. 6. Case vi. (*A*) narrowed joint space and posterior spurring between C-5 and C-6. (*B*) encroachment of foramen by calcium shadow between C-5 and C-6 on right. (*C*) large poorly circumscribed pressure defect obliterating nerve root at C-5, right.

mile train trip and on arrival had to have a narcotic to relieve this pain. He also noted that if he rotated his head and neck into one position or raised and abducted his arm, pain would be relieved. On physical examination there was limitation of motion in the neck, point tenderness over sixth cervical transverse process, weakness in the right hand, and hypesthesia of the right thumb. The right biceps and radioperiosteal reflexes were reduced. Roentgen findings are shown in Figure 6, *A*, *B* and *C*. A subtotal laminectomy at C-5 was done and fragments of herniated nucleus pulposus were removed. The pain was entirely relieved but the patient had some residual numbness in the tip of the right thumb. Postoperative roentgeno-

eral Hospital. His symptoms were greatly aggravated by the train ride. On physical examination there was slight general atrophy in the left upper extremity, a loss of the left triceps reflex and some weakness in the left grip. Pressure over the left sixth transverse process produced severe pain radiating into the arm, forearm and hand. Gentle compression and rotation of the head to the left markedly aggravated the patient's symptoms, reproducing particularly the precordial pain. There was hypesthesia in the index finger. For roentgen findings, see Figure 7, *A* and *B*. On July 3, 1945, a left subtotal laminectomy was done and a large herniated nucleus pulposus was found anterior to the seventh cervical root. This was removed; during

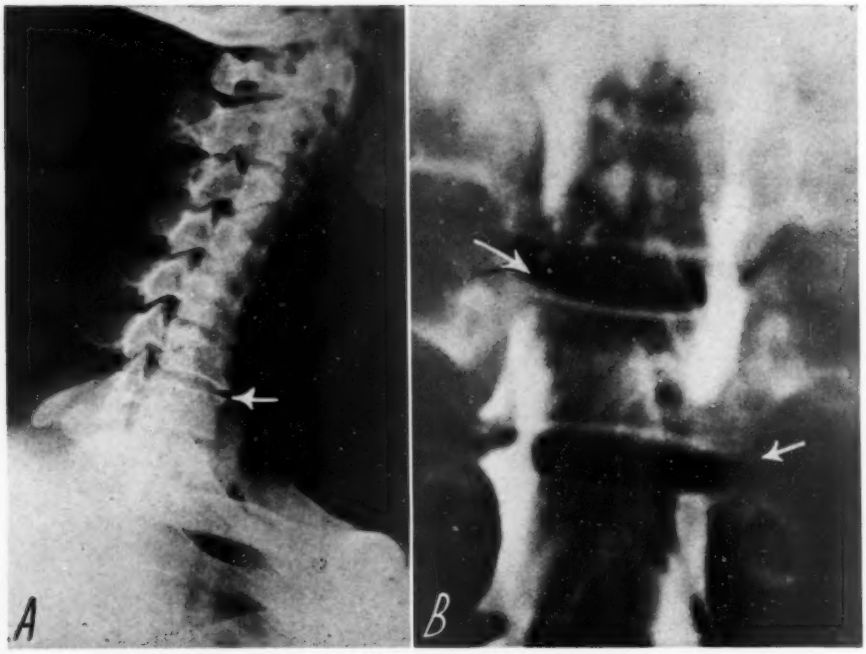

FIG. 7. Case VII. (*A*) reversal of normal curve; localized arthrosis of joint space between C-6 and C-7, evidenced by narrowing and anterior lipping. (*B*) obliteration of nerve root at C-6 on left and C-5 on right.

the operation it was noted that pressure on the disc reproduced the patient's precordial pain after the root had been injected with 2 per cent novocain. Immediately after operation the patient stated that all his symptoms had disappeared.

FIG. 8. Case VIII. (*A*) reversal of normal curve. Narrowing of joint space between C-6 and C-7 (*B*) large poorly circumscribed pressure defect with obliteration of inferior border of cuff of right nerve root at level of C-6. Pressure also present on spinal portion of subjacent nerve. (*C*) distortion of nerve root, narrowing of subarachnoid space, C-6, right. Defect in lamina from previous operative procedure. This was interpreted as either a recurrence or the result of scarring from the previous laminectomy.

Case viii. An officer, aged thirty-two, in 1938 had neck pain with radiation into the shoulder and right arm, of two days' duration. During the next five years he had five moderately severe attacks, lasting twenty-four to forty-eight hours, with residual soreness. On December 5, 1943, a severe attack took place overseas with pain which radiated into the outer arm, forearm and into index and middle fingers. The fingers of the right hand became numb. At an overseas hospital traction on the neck gave some relief, of pain and slight residual numbness in the index finger. The patient returned to duty.

In March, 1945, the patient was overseas and while lifting a tub of water had a recurrence of his old pain with the same radiation, but in this attack the numbness and tingling were in the fourth and fifth fingers. Three days preceding the onset of this pain the patient had been blown out of a jeep by a land mine landing on his head. Conservative treatment in the form of traction and physical therapy gave no relief.

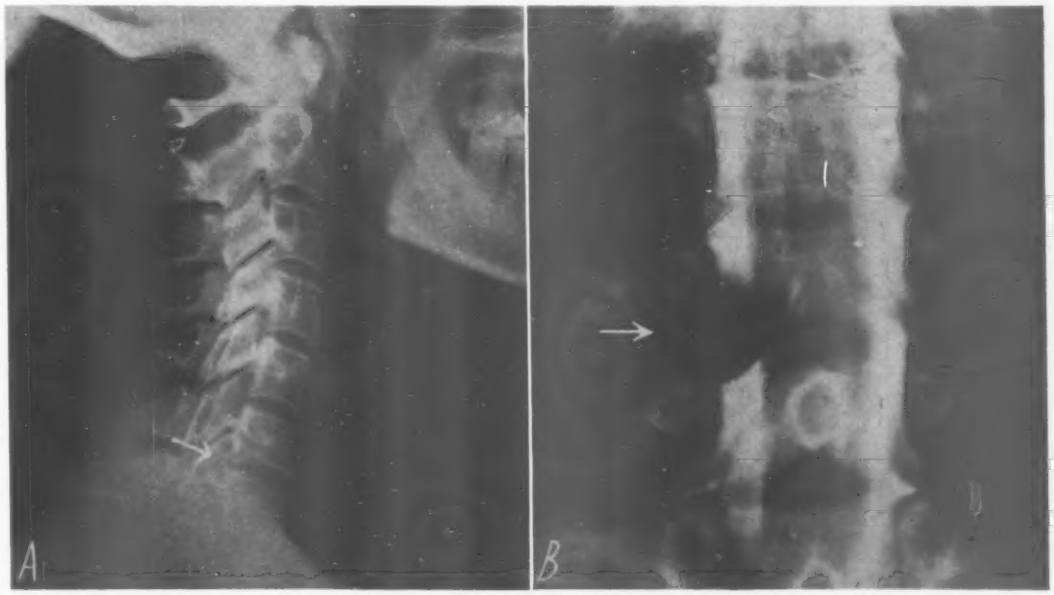

Fig. 9. Case ix. (*A*) segmental loss of curvature of lower spine with narrowing of joint space between C-6 and C-7. Posterior spurring also present at this level. (*B*) unilateral triangular defect at level of C-6 on right. Obliteration of nerve root cuff and displacement of spinal portion of root.

although narcotics were also used. Twisting neck to same side markedly aggravated pain as did coughing and sneezing. Past history reveals that patient was thrown from a horse in 1929 and suffered from a stiff neck as a result. On physical examination there was marked limitation of neck movement and marked tenderness over the scalenus anticus muscle at the level of the sixth transverse process. Rotation of the neck to the right reproduced pain. Right biceps jerk was reduced and hypesthesia in index and middle fingers was present. For roentgen findings, see Figure 8, *A* and *B*. A subtotal laminectomy with removal of a large herniated nucleus pulposus was done at the level of C-6 on the right. As a result there was a complete relief He was returned to O'Reilly General Hospital and myelography again performed (see Fig. 8*C*). The old wound was reopened at the level of C-6 on the right and several loose pieces of herniated nucleus pulposus were removed from the same level as at the previous operation. This second operation completely relieved this pain and numbness.

Case ix. A soldier, aged forty-two, developed neckache and right shoulder numbness in September, 1943. About one month later pain appeared on the outer aspect of right arm, forearm and thumb. He was hospitalized from duty on April, 1944. In May, 1944, he developed fibrillary twitches in triceps and biceps; atrophy

of upper extremity muscles was also noted at this time. Numbness in the right index finger, which was also present, persisted for six months. He was transferred to this hospital with a diagnosis of scalenus anticus syndrome. On physical examination pressure over the upper brachial plexus and rotation of the neck with pressure on the head reproduced pain. There was intermittent twitching in biceps and triceps muscles. The triceps and biceps jerks were questionably reduced but the pectoral jerk was definitely reduced. Subjectively the patient noted the right upper extremity to be cold especially in hot weather when doing heavy work. Roentgen findings are shown in Figure 9, *A* and *B*. A subtotal laminectomy, with removal of the herniated nucleus pulposus between C-6 and C-7, was done. There occurred a complete relief of all symptoms.

FIG. 10. Case x. (*A*) straightening of the normal curve and calcification in anterior ligament in joint space between C-6 and C-7. (*B*) small triangular defect obliterating inferior cuff of root sleeve at C-6 on right. Superior cuff displaced cephalad.

CASE X. An officer, aged forty-nine, had a stiff neck for one week in July, 1944. Heat and massage gave no relief. Three days after stiffness cleared up he developed a pulling sensation in his right neck which extended down inner border of the shoulder blade and radiated down the outer side of the right forearm into the index and middle fingers. He noted also a "hot spot" in the palm just proximal to the index finger. He could reproduce and exacerbate the pain by turning his head to the right and relieve it by turning his head to the left. Coughing and sneezing did not aggravate the pain. On physical examination compression and rotation of the neck to the right reproduced pain. There was marked tenderness over the upper right brachial plexus. The right biceps and triceps reflexes were reduced. Hypesthesia was present in the entire index finger and along the palmar surface of the middle finger, but less marked. No vascular changes were noted. Roentgen findings are shown in Figure 10, *A* and *B*. A subtotal laminectomy, with removal of the herniated nucleus pulposus between C-6 and C-7, was done. The pain immediately disappeared but some residual hypesthesia in the index finger persisted.

CASE XI. A soldier, aged thirty-five, landed on his right shoulder in a ditch as a result of a

FIG. 11. Case XI. (*A*) localized arthrosis at level of C-6. (*B*) encroachment of foramen. C-6, right. (*C*) large "gap" defect obliterating nerve root at level of C-6 on right.

shell explosion on June 25, 1944, in France. He developed stiffness in his neck and severe headaches and pain radiating into the right eye. This was followed by some weakness of his right arm, forearm, hand and shoulder during the next few months. In cold weather the right hand became purple. He was transferred from another Army General Hospital with a diag-

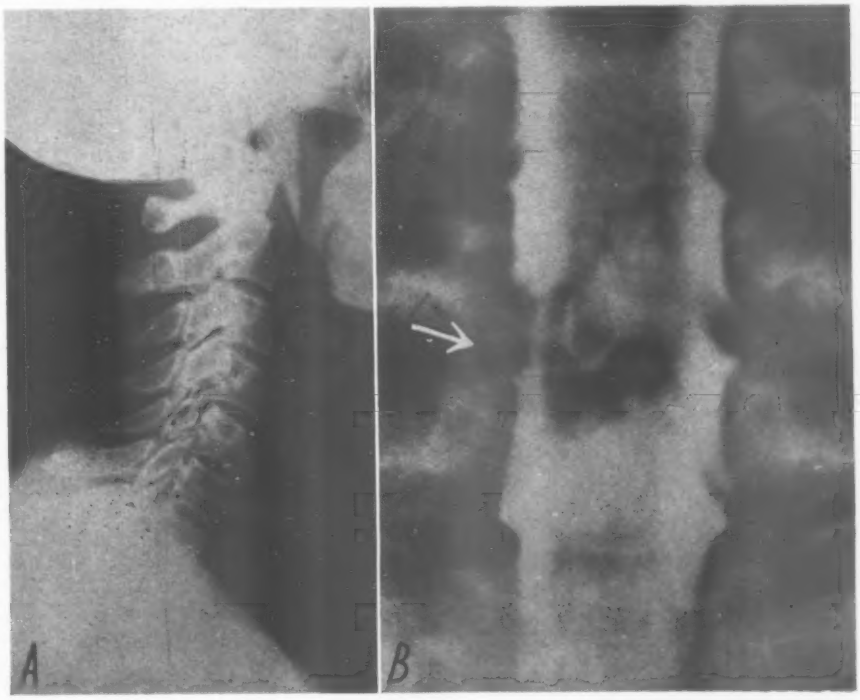

FIG. 12. Case XII. (*A*) normal curve. (*B*) large irregular "gap" defect almost obliterating nerve root at level of C-6 on right and extending to midline.

nosis of paralysis of the right brachial nerve. On physical examination the patient was unable to flex the distal interphalangeal joint of the right finger of the right hand. There was atrophy of the small muscles of this same hand, including the hypothenar and thenar eminence and particularly in the anatomical snuff box. There was numbness of the fingers and thumb of the right hand and an inability to adduct the little finger. Roentgen findings are shown in Figure 11, *A* and *B*. A subtotal laminectomy was done with removal of a large herniated disc. No improvement resulted.

CASE XII. An officer, aged forty, on December 1943, slipped on landing net, fell 3 or 4 feet and then caught net with right hand and swung on it. He felt as if he had torn something at the base of his neck. This was followed by pain in the neck, radiating to the shoulder, lateral aspect of arm, and numbness in the fourth and fifth fingers. The pain was fairly severe but he continued on duty until January 8, 1944. This was markedly aggravated by a long train trip. Treatment in a general hospital for five months with traction, a hard bed and physical therapy gave some relief. He went to duty but in October, 1944, he had a recurrence of stiff neck with pain radiating into the upper shoulder and ring and little fingers. This could be relieved by turning the neck in a certain position and increased by rotating the head and neck to the right. He was transferred to the O'Reilly General Hospital with a diagnosis of brachial plexus neuritis. On physical examination there was limitation of rotation of neck, hypesthesia in fourth and fifth fingers and decrease in the right triceps jerk. Rotation of the head and neck to the right, with compression on head, reproduced the patient's pain. There was marked tenderness over the scalenus anticus at the level of the sixth transverse process. Roentgen findings are shown in Figure 12, *A* and *B*. Patient was treated conservatively without any change.

SUMMARY

1. Rupture of the nucleus pulposus in the cervical region is relatively common.

2. In many cases the diagnosis can be made solely on the basis of the clinical findings.

3. Plain lateral and oblique roentgenograms of the cervical spine often provide helpful confirmatory information.

4. Positive cervical myelographic findings have proved highly accurate in this small series of operated cases.

5. The significance of negative cervical myelographic findings has not yet been completely determined although the evidence in this series suggests that a negative finding is of much more value than a negative finding in the lumbar region.

Lt. Col. Lucien M. Pascucci, M.C.
Saranac Laboratory
Saranac Lake, N. Y.

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THE PHANTOM NUCLEUS PULPOSUS

By J. GERSHON-COHEN, M.D.
PHILADELPHIA, PENNSYLVANIA

THE nucleus pulposus has received intensive study since the stimulating work of Schmorl[16] who directed particular attention to the subject of protrusions or herniations. Various infectious and degenerative diseases in connection with these protrusions have been described in the nuclei and in the surrounding tissues, among which might be mentioned nuclear expansion or ballooning, atrophy, calcification, infectious and malignant invasion. Another condition, only lately recognized,[10,11] is one in which there is a loss of the nucleus pulposus without tissue replacement leading to an empty space or "vacuum."

CASE REPORTS

CASE 1. A white female, aged fifty-six, slipped on a staircase eighteen years before and landed on her sacrum. Pain and tenderness occurred immediately in the lumbosacral area, sufficiently intense and persistent to confine her to bed for the succeeding two months. The condition then improved and the symptoms disappeared after five months. No evidence of fracture or dislocation was revealed by the original roentgen examinations and there never has been radiation of pain nor any positive associated neurological findings. Periodically since this episode, there have been recurring attacks of low back pain treated by every conceivable method devised by practitioners of recognized and unrecognized schools of therapy. At present there are no positive physical findings except slight limitation of motion of the lumbosacral articulation. The roentgen examination reveals the presence of an ankylosing hypertrophic osteoarthritis of the lumbosacral articulation with a phantom nucleus pulposus. Examination of the patient in the erect position bearing weight on the lumbosacral spine reveals no change in the roentgen findings, nor does examination during flexion on extension of this portion of the spine make any difference. The phantom nucleus has been found repeatedly at

FIG. 1. Case 1. Phantom nucleus pulposus of lumbosacral articulation, anteroposterior view—25° cephalic angulation of central ray.

FIG. 2. Case 1. Phantom nucleus pulposus of lumbosacral articulation, lateral view.

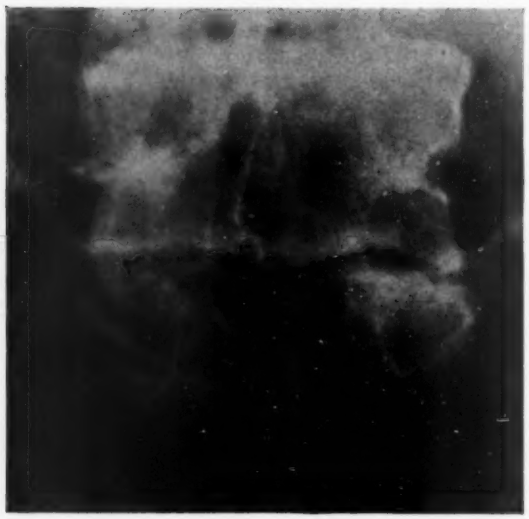

FIG. 3. Case II. Phantom nucleus pulposus of lumbosacral articulation. Anteroposterior view, 30° cephalic angulation of central ray.

each examination during the past two years (Fig. 1 and 2).

CASE II. A female, aged thirty-eight, fell out of a doorway of an automobile as it was going around a curve. She landed on her back and sustained several bruises, but no other injuries became apparent immediately. On the following day, she complained of a sharp low backache and this became progressively worse necessitating bed rest for two weeks. This condition gradually subsided during the next five weeks.

FIG. 4. Case II. Lateral view.

Since this initial episode, which occurred nine years ago, attacks of slightly incapacitating low back pain have recurred only three or four times, lasting never more than two to four weeks. The most recent roentgen examination was the first to reveal anything abnormal in the lumbosacral spine when a phantom nucleus pulposus was seen in the region of the lumbosacral articulation in association with minimal subarticular osteosclerosis of the first sacral segment. Only slight narrowing of the intervertebral space was present. The erect position of the patient with the spine in anteroposterior or lateral flexion or extension did not alter these roentgen findings (Fig. 3 and 4).

CASE III.* A male, aged fifty-eight, was felled by three prisoners whom he was guarding during the last war (1918) and thrown to the ground, kicked and trampled upon. He lost consciousness for almost twenty-four hours and then he found himself in a hospital with a sharp low backache which kept him confined to bed for 11 weeks. No evidence of fracture or dislocation was found and with bed rest and physical therapy, he gradually improved, being discharged back to active duty fourteen weeks after the date of injury. Never since then has he ever had any backaches that necessitated treatment; at least, so far as he could recall. During the course of a recent gastrointestinal examination, there was found incidentally, a hypertrophic osteoarthritis of the lower lumbar spine, characterized by minimal lipping of the articular margins of the bodies of the fourth and fifth lumbar vertebrae, subarticular osteosclerosis and phantom nuclei pulposi in this area. These vacuum spaces were best seen during extension of the lumbar spine (Fig. 5, 6 and 7).

DISCUSSION

In the 3 cases here reported, there was a history of a severe injury causing intense low backache incapacitating the patient for several weeks. In no instance was there evidence of fracture or dislocation of the vertebrae. Recurring intermittent backaches were experienced by 2 patients while the third apparently never was troubled again after the initial injury. Except for the unusual roentgen findings, none of the examinations revealed anything abnormal

* From the Roentgenologic Service, U. S. Naval Hospital, Newport, R. I.

except slight limited motion of the lumbosacral spine in 2 of the 3 patients.

In no instance was there neurological evidence of herniation of the nucleus pulposus, yet the history of injury and the localization of the spondylitis to the area of injury leads one to the inference that trauma had some connection with the initiation of the pathologic process. Neither rupture of the longitudinal spinal liga-

Fig. 5. Case III. Phantom nuclei pulposi between fourth and fifth lumbar and first sacral segments.

ments, loosening of the attachments of the annulus fibrosus, damage to the cartilage plates nor the reparative fibrosis in these soft tissues can be visualized in a roentgenogram, but the marked subchondral osteosclerosis, which was present in each case, would point strongly to injury and inflammatory reaction in and around the cartilage plates. It is conceivable that loss of nuclear substance took place through defects in these cartilage plates, but no evidence of herniation actually was visible in the vertebral bodies and no patient had symptoms of posterior protrusion of the nucleus pulposus.

The annulus fibrosus and the nucleus pulposus are separate structures even

Fig. 6. Case III. Lateral view.

though in adult life they may seem to blend together. The fibers composing the annulus are arranged complexly, one major group being connected with the hyaline cartilage covering the articular surfaces of the vertebral bony, anothea group in-

Fig. 7. Case III. Lateral view, with extension of spine, accentuating "vacuum phenomena" seen in Figure 6.

serting into the longitudinal ligaments and a third group sinking into the bony edges of the vertebral bodies like Sharpey's fibers. The overgrowth of bony tissue along the rim of the vertebral bodies, often referred to as osseous lipping and seen in spondylitis following injury, occurs in those portions of the body where these fibers of the annulus insert. It would be difficult to understand how extrusion of some nuclear material could be prevented in such cases, especially since the nucleus pulposus is always under tension. Could this mechanism, explaining the loss of nuclear substance in traumatic spondylitis, also explain the vacuum phenomena found by Knutsson[10] in cases of osteochondrosis juvenilis, a condition not always associated with trauma?

The *Randleiste* of Schmorl or the epiphyseal peripheral bony rings which develop during adolescence, first reveal small foci of calcium between six and eight years of age in girls and seven and nine years of age in boys. These foci ossify and fuse to form marginal bony rings surrounding the superior and inferior brims of each vertebral body with which they begin to fuse between fourteen and fifteen years of age. This fusion becomes complete at twenty-one to twenty-five years, being slowest in the lumbar area. Schmorl showed how fibers of the annulus fibrosus are firmly anchored in these epiphyseal rings which are the structures apparently most involved in adolescent osteochondrosis. The disintegration and aseptic necrosis of these *Randleiste* disturbs the integrity of the annulus fibrosus and the cartilage plates so that dissection, seepage, or absorption of some nuclear substance might occur under these circumstances. If the adult nucleus pulposus cannot seep easily through rents in the annulus because of its fibrogelatinous texture, at least in younger subjects when its water content is relatively high,[14] leaks in the annulus or in the cartilage plates easily may allow seepage or absorption to take place. This theory is not difficult to accept since herniation of the nucleus pulposus has been reported following simple lumbar puncture.[6,13] Since the nucleus pulposus is derived from endoderm, being in part a remnant of the notochord, any loss of its substance is not renewable like synovial fluid in other joints. In *osteochondrosis juvenilis*, once there has been a loss of some nuclear material, the emptied space can be enlarged by extension of the spine, effecting sufficient reduction in atmospheric pressure to result in the vacuum phenomena described by Knutsson. In *hypertrophic osteoarthritis*, after the loss of nuclear substance, the fibrohyaline annulus fibrosus prevents actual contact of the opposing articular surfaces because of its interposed position between the vertebral bodies. The space formerly occupied by the healthy nucleus thus is *not* encroached upon and this empty space remains a "vacuum" which can be roentgenographed. This space can be demonstrated more easily by traction or extension of the spine, but not so easily as in osteochondrosis because of the greater periarticular ankylosis.

A congenital central cavity in the nucleus pulposus has been described and this has been compared to a rudimentary joint cavity. Saunders and Inman[15] thought that these central cavities resulted from "desiccation" of the nucleus pulposus, but Coventry, Ghormley and Kernohan[2] ascribed their appearance to the exigencies of sectioning and staining for microscopic study. The possibility of a congenital cavity in the nucleus pulposus is not to be dismissed entirely in appraising the appearance of the phantom nucleus pulposus.

The healthy nucleus pulposus acts as a hydrodynamic ball bearing. It is under tension which is greater in youth than in old age. If nuclear material is lost, either by extrusion, dissection, absorption or atrophy following damage by mechanical or infectious forces, the disc cannot transmit the spinal column stresses and strains without increasing the wear and tear on apophyseal joints and perispinal ligaments. The pain and rigidity of adolescent osteo-

chondritis and ankylosing spondylitis apparently are due in some measure to these factors. While Magnusson[11] may have regarded the "vacuum phenomena" of the nucleus pulposus as mere curiosities, it is true that the intervertebral joint suffers an important physiologic handicap in the loss of the nucleus pulposus.

In posterior protrusions of the nucleus pulposus which produce symptoms, narrowing of the interarticular spaces between the vertebral bodies is seen rarely. The evacuated nuclear space is filled possibly by the swollen and redundant fibers of the annulus fibrosus. In only 2 cases of 88 pathologic specimens did Coventry, Ghormley and Kerohan[2] find gross evidence of thinning of the intervertebral disc in cases of posterior nuclear protrusions. They usually found some nuclear residues, often necrotic and pigmented in character.

The intact anatomical joint space was roentgenographed more than thirty years ago by Fick[5] and his co-workers, curiously enough in the Röntgen Institute in Würzburg. By using traction on the joints, they were able to create an intracapsular vacuum which revealed the intracapsular space. Dale[3] in 1930 reported on the presence of a radiolucent line in the symphysis pubis of gravid women late in pregnancy; later, Grashey,[8] von Pannewitz,[12] Hippe and Hähle,[9] and Widmann and Stecher[17] reported on spontaneous visualization of the interarticular joint space. Dittmar[4] in 1932 demonstrated how the knee menisci could be roentgenographed by intentional traction or abduction of the knee and the application of this procedure in the study of internal derangement of the knee joint has been reported recently.[7] Now it is generally recognized that almost any joint in the body can be demonstrated in the living by traction sufficient to create a vacuum in the capsule. Magnusson,[11] who studied the physical conditions which would produce evaporation of synovial fluid in a joint, pointed out that the intracapsular pressure would have to be reduced to one-twentieth of an atmosphere to produce a "vacuum phenomenon." Other factors in this mechanism of practical importance may be the flexibility of the periarticular soft structures and the amount of synovial fluid in relation to the size of the potential intracapsular space. In one instance, with a relatively large quantity of fluid, and with inelastic capsular-pericapsular structures, even vigorous mechanical traction may fail to achieve a sufficient reduction of intracapsular pressure to produce a discernible vacuum in the roentgenogram. In another instance, with a large capsular space, with a small amount of synovial fluid and with elastic pericapsular structures, mechanical traction may easily cause a visible roentgenographic vacuum. Vacuum phenomena in the healthy joint has received little study, but even less attention has been paid to this condition in the diseased joint.

Knutsson found vacuum phenomena in at least two different conditions: (1) in cases of disc degeneration (osteochondrosis), and (2) in cases of spondylitis deformans. In osteochondrosis, he described drying of the disc substance during the process of degeneration and since the annulus fibrosus remains intact, irregular air streaks corresponding to the cracks in the dried portion of the disc appear in the roentgenogram. The width of these cracks in the degenerated discs may sometimes be widened by extension of the spine when the increased vacuum so produced becomes more prominent. Knutsson claims that these vacuum streaks in the region of the degenerated disc may be the only positive roentgen sign of osteochondrosis, appearing before or without the development of the other usual roentgen signs. In spondylitis deformans, cracking and partial detachment of the annulus fibrosus may occur, so that the vacuum phenomenon extends beyond the confines of the nucleus pulposus. This is the only point of differentiation Knutsson makes of the vacuum phenomena between osteochondrosis and spondylitis deformans.

The roentgenologist has contributed

much to the diagnosis of nuclear protrusions and disease and now, perhaps, besides the use of intraspinal contrast media, he can add more by studying the vacuum phenomena in healthy and diseased joints.

SUMMARY

The phantom nucleus pulposus results in the roentgenographic appearance of an empty space or vacuum in that portion of the intervertebral disc normally occupied by this structure. This phenomenon is described in three cases of traumatic spondylitis in the lower lumbar spine and in the lumbosacral articulation. The mechanism leading to this condition in relation to other abnormal changes of the nucleus pulposus is discussed. Use of the roentgenographic "vacuum technique" to demonstrate the healthy and diseased joint and its diagnostic possibilities for the further study of joint diseases is reviewed.

255 South 17th St.
Philadelphia, Pa.

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ROENTGENOGRAPHIC PREPARATIONS FROM GROSS ANATOMIC SECTIONS[1]

By HAROLD O. MAHONEY, B.A., BARRY J. ANSON, PH.D. (MED. SCI.), *and* ROY F. DENT, M.D.
CHICAGO, ILLINOIS

IN THE study and teaching of roentgenographic anatomy a knowledge of the location of the various structures within the human body and their relation to surrounding organs, muscles and bones is of fundamental importance. The proper "positioning" of the patient during the roentgenographic examination and the manner of surgical approach are dependent upon such information. The need for more precise information of this kind led us to devise the method and the apparatus described herein. Regular methods were first employed, but were found to be unsatisfactory, because of the difficulty encountered in maintaining normal relationships among sectioned structures, and because of the impracticability of using gross sections in laboratory teaching or for extramural lectures.

Gross sections, though limiting the observer to a portion of each organ or system, reveal most graphically the location of all anatomic parts, and their relation to all important topographical neighbors. Ordinary sections, however, are unwieldy; they darken upon exposure to the air; their elements are easily dislodged or distorted; they require excessive space for storage and they are difficult to transport; they give no hint of histologic detail, and in them the course of vessels and nerves, of muscle fascicles, or of smaller hollow viscera can be followed only by destructive probing. Despite these common handicaps, little improvement in the preparation or exhibition of sections has been made since they first came into general use. Traditionally, the cadaver was fixed in formalin, frozen, and then cut by hand or by band saw, in rather thick sections; the sections were then left free and unguarded for examination, or mounted in alcohol (in brass trays, covered by glass plates sealed with wax).[2]

It was our ambition to cut sections thin and uniform, and to prepare convenient, life-sized, pictorial records of these originals. By these means, relationships could be shown at more frequent levels; sections would be uniformly thick throughout their breadth; they could, by photography, be converted into a form convenient for demonstration, storage and transportation; by roentgenography, the internal relations could be demonstrated, and some of the macroscopic structure, intermediate between the gross and the microscopic, could be brought out to view.

The articles of equipment employed were as follows: Vaughan high-speed band saw; special table with tracked top and demountable support (Fig. 1); imbedding

[1] Contribution No. 437 from the Department of Anatomy, Northwestern University Medical School; a study carried out in association with the General Electric X-Ray Corporation. All special exhibition cases, etc., were provided by General Electric, from specifications prepared by H. O. Mahoney and R. F. Dent.

Roentgenograms prepared in the manner herein described were exhibited first at the Kansas City (1936) meeting of the American Medical Association (awarded Honorable Mention); by invitation at the meetings of Illinois State Medical Society, Springfield, 1936 (Certificate of Merit), Fifth International Congress of Radiology, Chicago, 1937, and at the San Francisco (1938) meeting of the American Medical Association. A set of roentgenograms is on permanent exhibition at the Army Medical Museum, Smithsonian Institute, Washington, D. C.

[2] Cross-section containers, designed by Prof. W. W. Looney of the Baylor University College of Medicine, have been purchasable for some time. They consist of a circular aluminum tray, the front of which is glass set airtight in rubber. Sections are mounted in plaster of Paris, the compartment filled with preservative through an orifice which is then closed by a screw plug. Each can be suspended from the wall by a hook; they can be removed for study at table. They are available in sizes large enough to accommodate all transverse sections, except those taken through the shoulder region. So far as we know, larger containers of similar type (for sagittal and coronal sections) have not been successful; the glass covers are prone to crack, and the assemblage is unwieldy.

Even if such preparations were, from the mechanical standpoint, wholly satisfactory for local display within a medical school, they would not be adaptable to extramural teaching, since, in many states, such material could be transported only by licensed embalmers. And no matter how skillfully they may be prepared, the actual section is not as analytical as a roentgenogram prepared therefrom.

box; refrigerating (and dehydrating) unit; General Electric X-ray machine; large-field camera and enlarging apparatus; display cases for roentgenograms (Fig. 2 to 4).

It was found, through repeated trials, that a section three-fourths of an inch thick is most satisfactory; a slice of such thickness gave minimal superimposition of tissue, while offering sufficient bulk to hold the various structures in place without artificial aids. In order to produce a uniform slice of optimum thickness, in the various planes—transverse, sagittal and coronal—a movable platform is required to feed the anatomical piece to the stationary saw (Fig. 1). The platform travels past the saw blade on rollers running on a metal track, the latter being mounted on a table. On the side of the table nearest the saw a ledge is mounted, against which the ice or paraffin block, with imbedded specimen, rests during cutting. The shelf is attached to the table top by hinges which allow it to be brought to a horizontal position, thus permitting the removal of the section from the table to a wire-mesh framed screen without danger of disturbing the loosened structures (intestine, brain, etc.). The position of the hinged shelf in relation to the saw blade determines the thickness of the cut. A newly set blade should be used for each cadaver. The rate of speed at which the part should be cut varies with the structures through which the saw must pass; to force the cutting is to produce uneven slices. Experience has shown that moderate travel is best for all parts except the teeth and the petrous portion of the temporal bone; to compensate for their resistance, the switch should be set to operate the saw at high speed, or the speed of travel of the table reduced.

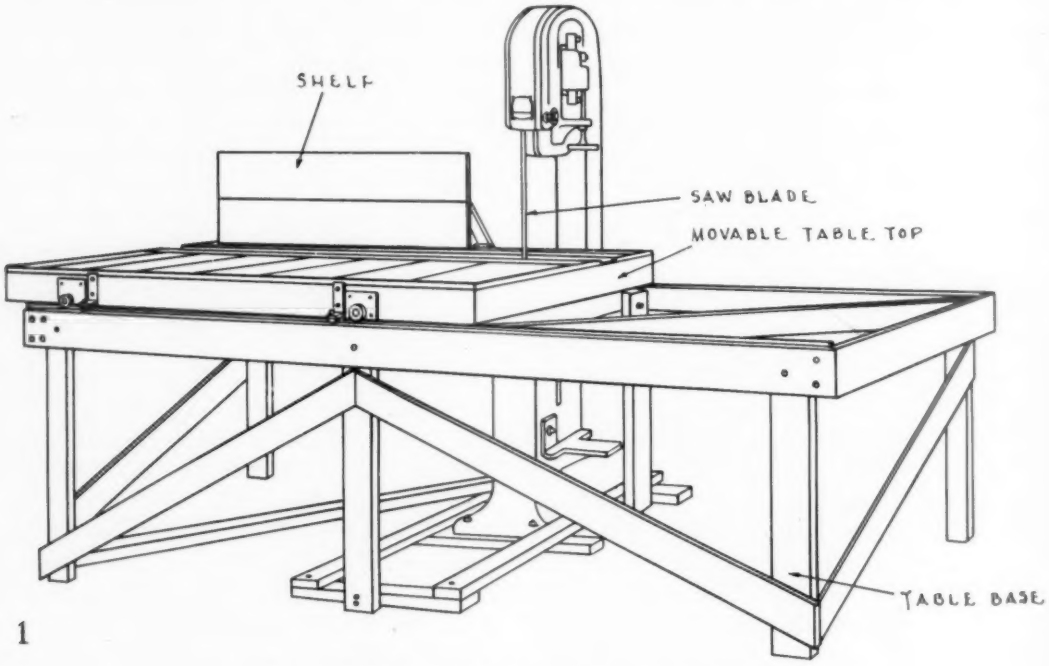

FIG. 1. Band saw with table carrying tracked top.

A demountable box is used to hold the imbedded cadaver. Care should be exercised to construct it with sides and ends meeting the floor at right angles. Into this the specimen is fitted in supine position. The specimen should be formalin injected (10 per cent solution); during the process the cadaver should be straight, every effort being made to avoid lateral flexion of the vertebral column and flexion of the ex-

tremities. After injection, the cadaver should be refrigerated for at least five weeks. In preparation for cutting, cotton is placed in the nostrils, ears, and mouth; all hair is shaved from the body, and the extremities are removed for separate sectioning. The upper extremities should be cut through the axilla in the parasagittal plane, and the lower extremities transversely cut just below the tuberosity of the ischium.

The part to be sectioned (trunk or extremity) is placed in the box with the long axis of the body in correspondence with that of the box. Melted paraffin is then poured over the part until it is completely covered. The box is then placed in the refrigerator for twenty-four hours to hasten the process of hardening. Long freezing results in too great dehydration, and usually causes paraffin to break away from the specimen in the process of cutting.[3]

As each section is cut it is washed to remove blood, intestinal contents and other residue; then it is transferred from the hinged shelf of the rolling platform to a screen or to a sheet of heavy strawboard for temporary storage preparatory to being used in any one of several ways hereinafter described.

If the sections are to be employed for class instruction in the regular course in gross anatomy, or for more specialized examination and demonstration in topographical anatomy, they may be kept in humid metal boxes[4] or mounted in fluid.[5] Even if they are to be employed in this conventional way, the superiority of sections prepared in the manner just described would warrant building of the special table and imbedding unit. However, the teaching possibilities of such sections can be exhausted only by using them, also, for photography and roentgenography. This matter calls for further discussion.

For class instruction sections are discouragingly awkward: as customarily prepared they cannot be demonstrated to large groups; they are generally unwieldy to store and awkward to transport. Only the anatomical features on their surfaces (or one surface, if mounted) are evident. Natural-sized photographs of the sections prove to be highly adaptable; they are easily transported, require surprisingly little space when stored, and can be demonstrated to large groups. Even more useful are roentgenograms prepared from the same gross sections; when accompanied, in lecture-demonstration, by the photographs referred to above, the value of the roentgenograms is further increased, since the internal morphology of the individual section is revealed to the observer.

In roentgenograms of sections, three-dimensional detail is recorded to an astonishing degree. Noteworthy among the macroscopic features clearly visualized are the following: ramifications, in the liver parenchyma, of hepatic and portal blood vessels; course, from origin to insertion, of fascicles of the coarser skeletal muscles (glutei, adductores, obturatores, sacrospinalis, recti abdominis, psoas, etc.); course of mesenteric arteries from aortic source to intestinal termination; lumbar nerves, from medullary origin through vertebral and intervertebral and intermuscular course; dural infoldings in relation to cerebral and cerebellar hemispheres; dural venous sinuses; carotid vessels; great vessels leaving and entering cardiac chambers; trabecular elements in long and in flat bones; internal supporting ligaments of the major joints of the extremities; pulmonary ramifications of blood vessels and bronchi; perineal contents in relation to fascial plates.

The preparation of photographs of the sections requires nothing novel in the way

[3] The use of ice as an imbedding medium was tested, but was found to be unsatisfactory.

[4] A metal box with tray-like false bottom is best. Dilute phenol solution (5 per cent), in rather small amount (and not reaching the tray), will suffice; it will not only keep the atmosphere humid, but will also serve to prevent molding of such small detached pieces of the section as may collect at the bottom of the container.

[5] Very satisfactory "pans" for museum display of individual sections can be made of brass. The section is imbedded in plaster of Paris, a glass cover fitted snugly into the pan. Alcohol (70 per cent) is used as preservative. A minute opening is made in the glass to permit escape of excess fluid as the cover is fitted into place; the vent is then closed with wax. Wax may be used to seal the cover in place.

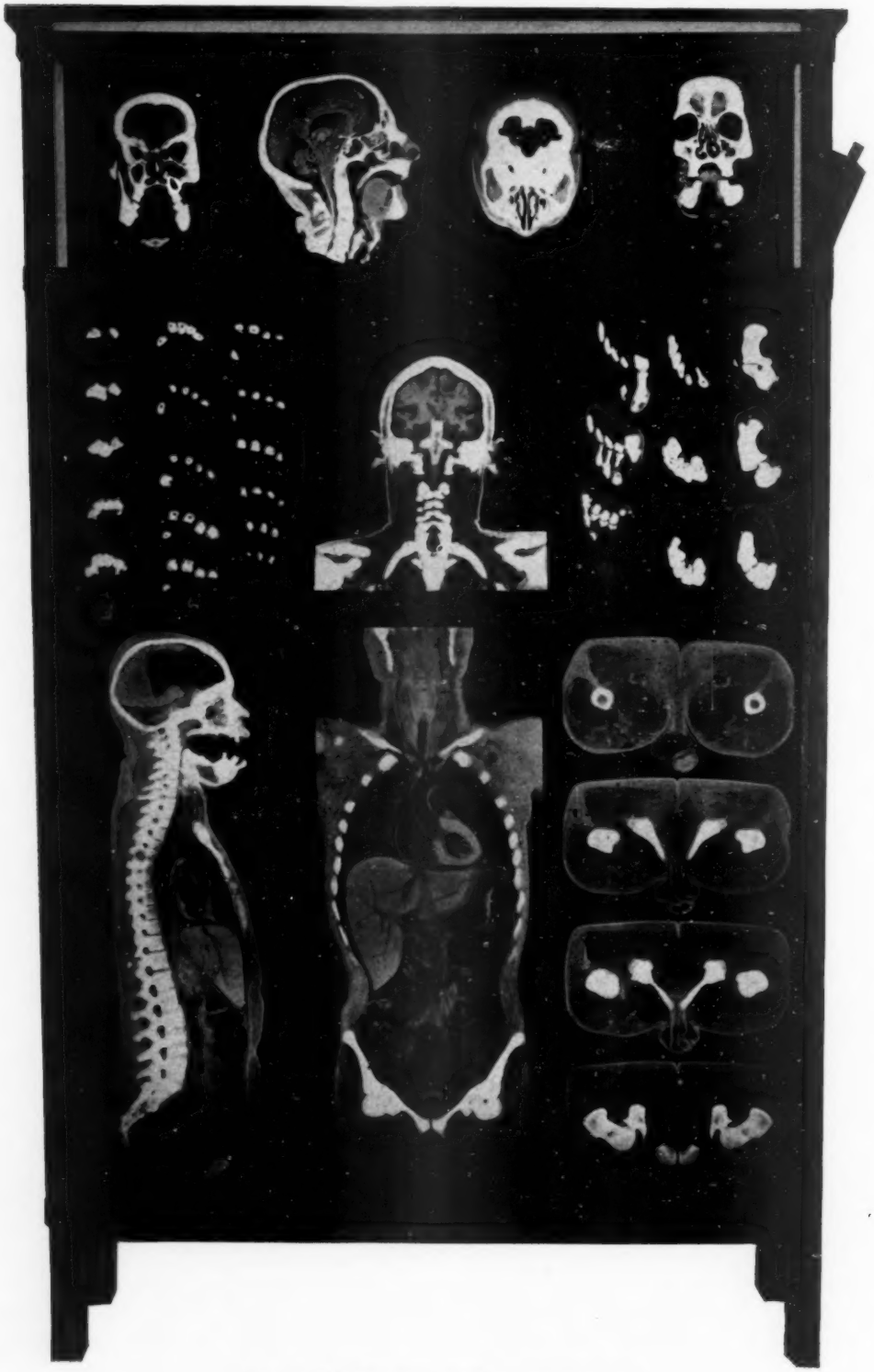

Fig. 2. Display case with roentgenograms.

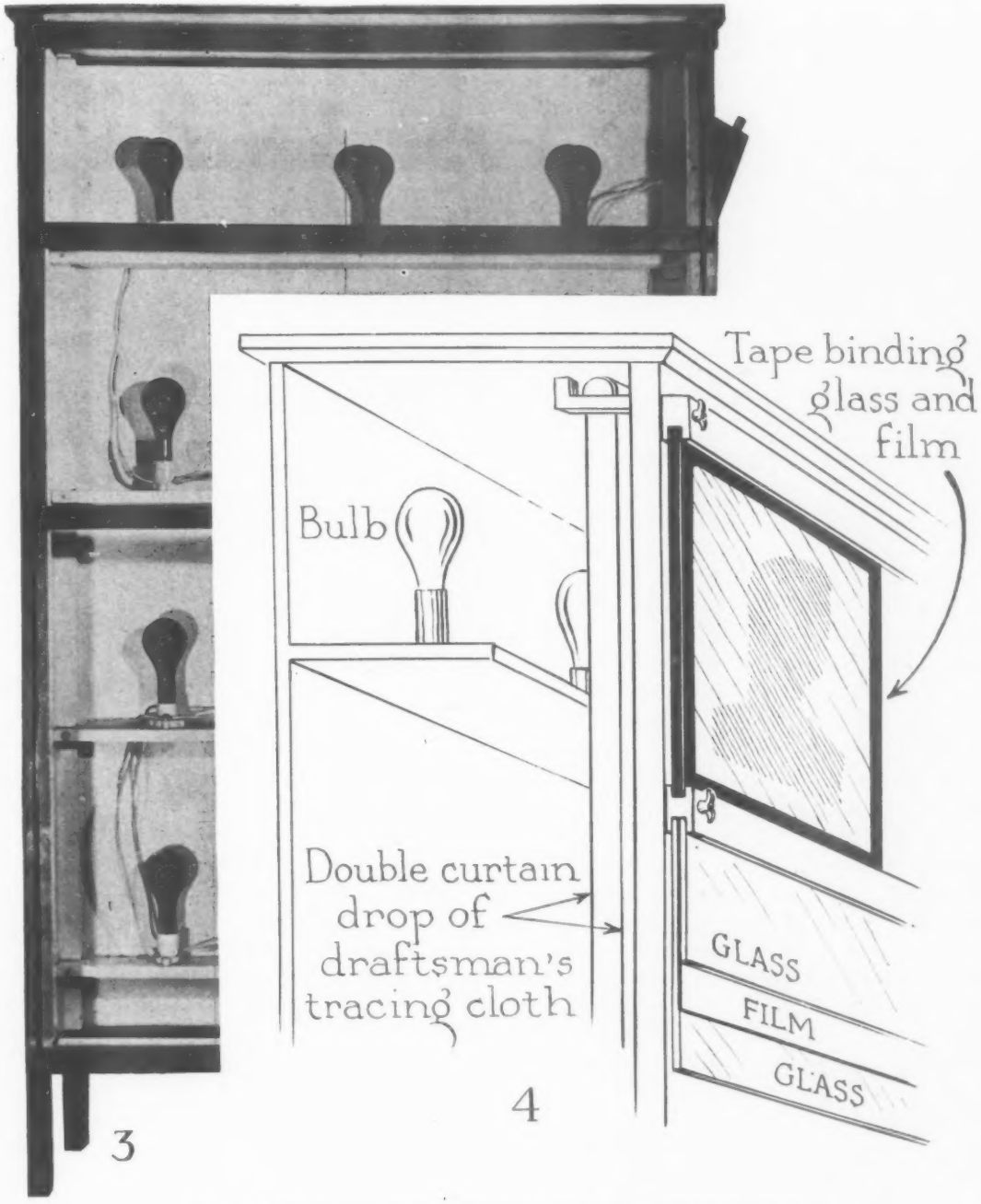

Fig. 3. Display case; curtain removed to show illuminating units.
Fig. 4. Display case; details of structure. Illustrating method of mounting films between plates of glass and of holding plates in grooved supports in front of translucent cloth.

of technique or equipment; however, new methods and apparatus are needed for the preparation of the roentgenograms and special exhibit cases are required for their advantageous display (Fig. 2 to 4).

In order to render the sections suitable for roentgenography, slow but considerable drying is essential. This is accomplished by storing them in the refrigerator for approximately a year, during which time they

should be examined periodically; optimum desiccation is that marked by separation of muscle fascicles, and retraction of the latter from the investing fascial layers. Usually this is a reliable indicator for all of the other tissues. However, in some instances parenchymatous organs hold fluid longer than do muscles, so that trial roentgenograms must be taken. When tissues are still soggy with contained embalming solution, the area affected appears blurred in the roentgenogram, and is completely wanting in details of macroscopic architecture. Storage on trays made of wide-meshed screen held by frames is desirable; in this way drying is uniform from both cut surfaces. When trays are piled in tiers, blocks should be placed between frames to prevent adjacent sections from touching eachother.

In making the roentgenograms a mobile General Electric unit is used, the pictures taken on non-screen film.[6] In our series a complete set of roentgenograms was prepared of each of three cadavers, sectioned in transverse, sagittal and coronal planes; for the transverse series an upper and a lower extremity were sectioned. Recognizing that much of the teaching value, for medical students, of such material depends upon its availability for continued reference as an auxiliary to dissection, special exhibit cases were prepared for display of the roentgenograms. These are essentially an enlarged form of roentgenogram viewing unit (Fig. 2). Each is a free-standing wooden case having the following dimensions: height 5½ ft., width 4 ft., depth 1 ft. The case, open in front, is provided with with twelve 150 watt lamps, arranged in three horizontal sets. In front the case is provided with wooden cross pieces, movable up and down, and provided with wingbolts by which they can be fixed at selected horizontal level, to accommodate roentgenograms of different sizes (Fig. 3 and 4). For proper diffusion of the light, a curtain of draftsman's tracing cloth is hung in front of the bulbs. For classroom or museum display the roentgenograms are mounted between glass plates which are fastened together with Scotch tape (Fig. 4). Since the slotted supports are adjustable, the smaller transverse sections can be displayed adjacent to the larger coronal or sagittal sections whenever it is helpful to invite comparison between horizontal and vertical relations, or to employ one of these to supplement the other.

Roentgenograms, even when mounted in protecting glass, are not bulky; in a laboratory they can be stored conveniently. For use in more mobile form, for extramural lectures, they may be used unmounted—as roentgen films are regularly handled. Then the roentgenograms covering the three full series can be transported in a single box of the kind used in commercial shipping of original negatives.

Any one of the series of anatomically complex roentgenograms may be made much more serviceable for semipermanent or permanent display by placing next to each roentgenogram a labelled adumbration; the latter is prepared simply by tracing the structures on translucent paper and adding leaders and labels with india ink.

[6] The exposure factors were 25 kv. (peak), 5 ma., 72 inch distance and 20 to 60 seconds, depending upon the thickness of the sections and the degree of dehydration.

ABERRANT PANCREAS

By LIEUTENANT COLONEL ARTHUR J. PRESENT
MEDICAL CORPS, ARMY OF THE UNITED STATES

THE presence of aberrant pancreatic tissue in various portions of the abdomen and particularly in the wall of the gastrointestinal tract is not uncommon. It is of sufficient frequency to warrant its consideration in the differential diagnosis of so-called "filling defects" noted in the course of barium studies. Most of such nodules are small, cause no symptoms and have been found during post mortem examinations or incident to surgery. However, a sufficient number of cases have been reported in which the ectopic tissue caused or was associated with obstruction, intussusception or other abnormalities to warrant consideration of these masses as something more than anatomical curiosities. In addition to these mechanical complications, it is recognized that such tumors may be subject to pancreatitis, malignant change and to proliferation of islet tissue producing hyperinsulinism.

Examples of all of these conditions are to be found in the complete review of the reported cases of aberrant pancreas up to 1939 by Faust and Mudgett.[1] Mitchell and Angrist,[2] in 1943, added 11 cases of their own and collected 21 additional instances from the literature. Since that time Troll[3] has reported 3 cases, Chapman and Mossman[4] 1 case, and Brown, Flacks and Wasserman[5] a single case. The latter case was seen roentgenographically in the duodenum. A single case of unusual interest was not included in previous reviews. Reported by Ballinger[6] as the only known instance of aberrant pancreas in the liver, the patient had presented symptoms of hypoglycemia for six months prior to death. Postmortem examination revealed a carcinoma of the ectopic nodule, largely islet tissue, with no evidence of adenoma or primary carcinoma in the pancreas. A summary of the collected cases, with the 2 cases here reported included, is indicated in the following tabulation:

Stomach	110
Duodenum	117
Jejunum	68
Ileum	21
Small intestine (not located)	6
Diverticulum—stomach	3
Diverticulum—duodenum	7
Diverticulum— jejunum	1
Diverticulum—ileum	8
Meckel's diverticulum	27
Diverticulum of small intestine (not located)	2
Diverticulum (not located)	1
Umbilical fistula	1
Mesentery	3
Omentum	4
Liver	1
Splenic capsule	3
Spleen	1
Gallbladder	5
Cystic duct	1
Gastrocolic ligament	1
Transverse mesocolon	1
Location questionable	18
Total Cases:	410

It is apparent that the most frequent location of aberrant pancreas is, as might be expected, near the normal pancreatic bed. About one-fourth are reported in the stomach. Only in 1 or 2 instances have such tumors been visualized on roentgenograms.

Two cases, both in the antrum of the stomach, were studied roentgenologically at Hoff General Hospital, Santa Barbara, California.

CASE 1. The patient, a white male, aged thirty-three, was admitted on March 9, 1942. He complained of "stomach trouble" which had been present for two or three years and which was manifested by loss of weight, intermittent nausea, vomiting and hematemasis. There had been some epigastric pain, not persistent, with a variable relationship to eating. Milk gave re-

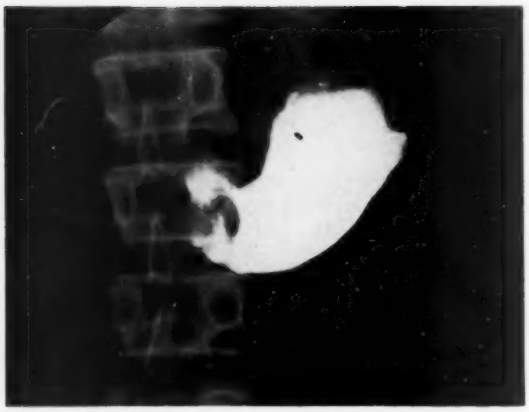

Fig 1. Case 1. Intramural pancreatic nodule.

lief but none was obtained from alkaline powders. Tarry stools had been noted. Physical examination revealed evidence of weight loss, poor oral hygiene, chronic tonsillitis and tenderness in the mid-epigastrium and right upper quadrant. Laboratory studies were negative except that blood was found in all gastric specimens and in the stools. The sedimentation rate was 31 mm. per minute.

Roentgenographic studies of the gastrointestinal tract demonstrated no abnormalities of the esophagus. The proximal stomach was essentially normal. In the immediate prepyloric region a smooth, round, filling defect was persistently noted on the greater curvature (Fig. 1 and 2). This could not be erased by palpation but was movable and seemed small and intramural. Peristalsis did not pass through the area, but the mucosal pattern was seen to change. The duodenum was not unusual. A 5–10 per cent gastric retention was present at six hours.

Three gastroscopic studies were performed in an effort to visualize this deformity. The first two were noteworthy because, despite fair visualization, no abnormality was seen. The third revealed a suggestion of a mass interpreted as an intramural antral tumor.

At surgery a firm mass was found on the posterior and inferior aspect of the pylorus. Adherent to this mass was a cone of tissue which proved to be pancreas. The right half of the pancreatic bed was empty and the left contained what was felt to be pancreatic tissue lying obliquely and pointing up toward the stomach. The pylorus seemed to be obstructed by the mass and the cone of tissue could not be dissected away because of vascularity. A Finney pyloroplasty was done. Convalescence was rapid and gastric symptoms disappeared. A postoperative roentgen examination showed the pyloric defect still to be present, but there was no retention in the stomach.

Case 11. The second patient was a white soldier, aged thirty-three, admitted to Hoff General Hospital on April 7, 1944. He complained of intermittent right upper quadrant pain of five years' duration, occasionally shifting to the mid-upper abdomen. It was dull, aching and accompanied by nausea. These symptoms usually followed constipation of two or three days' duration and were relieved by catharsis or enemata. Infrequent vomiting had occurred. In 1940 a gastrointestinal series and gastroscopy had been performed prior to entry on military service, and the patient had been told that a polyp had been found.

On physical examination a reducible right, incomplete, indirect inguinal hernia was the only positive finding. All laboratory studies were within normal limits. Roentgen studies of the gastrointestinal tract showed two large areas of diminished density in the barium shadow of the antrum (Fig. 3 and 4). One, the superior, appeared to be a fold of mucosa and could be displaced on palpation. The second, on the greater curvature, persisted despite manipulation and was well visualized as a polypoid lesion on spot roentgenograms. The entire area was flexible. Gastroscopically a polyp 2 by 2

Fig. 2. Case 1. Spot roentgenogram of intramural tumor.

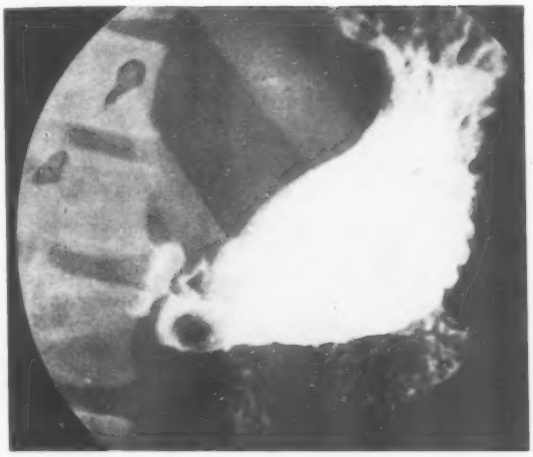

Fig. 3. Case II. Polypoid tumor of antrum.

Fig. 4. Case II. Spot roentgenogram showing polypoid tumor.

cm. in diameter was seen in the prepyloric region. At surgery a soft, round mass, 2 cm. in diameter, was found 4 cm. proximal to the pylorus on the greater curvature. It was resected and, on study, was found to be a cyst measuring 1 by 1.8 by .8 cm. filled with clear, watery fluid. It had a base of firm white tissue 9 mm. thick which was recognized as aberrant, fairly normal appearing pancreatic tissue with the "cyst" a dilated duct. The entire tumor lay beneath the muscularis mucosa and in the muscularis proper. Convalescence was uneventful and the inguinal hernia was later repaired after which the patient was returned to duty without symptoms.

DISCUSSION

The roentgen findings in these 2 cases differed considerably. The first case was the more puzzling because of the size of the tumor and the intact mucosa. It was believed to lie in the wall, to be benign and to cause the delay in emptying. The second case presented the fairly typical elements of a polyp and was similar in all respects to the case of Faust and Mudgett.[1] In neither instance was the true nature of the condition recognized preoperatively. The lesion was undoubtedly the cause of the symptoms in the first patient and an incidental finding in the second.

SUMMARY AND CONCLUSIONS

1. Two cases of aberrant pancreas in the antrum of the stomach are reported.

2. The cases which have appeared in the literature to date are tabulated.

3. The suggestion is made that ectopic pancreatic tissue be considered in the differential diagnosis of apparently benign intramural tumors in the upper gastrointestinal tract as visualized roentgenographically.

115 South Stone Ave.
Tucson, Arizona

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THE PANCREAS AND ITS RELATION TO PSORIASIS, ECZEMA AND CERTAIN OTHER DISEASES OF THE SKIN*

By W. A. QUIMBY, M.D.
WHEELING, WEST VIRGINIA

THE importance of the pancreas in the human economy has its counterpart in diseases and abnormal functions. Much of this conduct of the gland we have been slow to recognize. Observations point to the pancreas as being responsible for psoriasis, eczema and certain other diseases of the skin.

Functionally the pancreas produces an external alkaline secretion containing the digestive enzymes trypsin, amylopsin and lipase. This secretion, well over one liter per day in amount, is conducted by way of the pancreatic duct, which usually terminates an orifice common to it and the bile duct to the duodenum. According to Meakins[12] "The external pancreatic secretion is stimulated by a hormone produced in the mucous membrane of the small intestine which is called secretin." He says, "Therefore, if for any reason the mucous membrane of the small bowel be grossly destroyed or atrophied, pancreatic activity may be impaired." The cells of Langerhans produce the internal secretion.

Pancreatic secretion, according to Glasser,[8] is usually isotonic with plasma and the distribution of the cations resembles fairly closely that of plasma. His analysis shows that sodium is the most abundant element and HCO_3 is the most prominent radical. The composition of this fluid is known to vary with the mode of stimulation and rate of flow being under nerve control of the celiac, mesenteric and splenic plexus. Glasser says further that "The energy metabolism of the pancreas has not been widely investigated. Practically nothing is known of the exact materials burned and nothing is known of the manner of application of the energy. About all that can be said is that oxygen consumption of the gland increases with activity irrespective of blood flow."

The concurrence of cholecystitis and diseases of the pancreas has long been recognized by clinicians and surgeons. When discussing the etiology of acute pancreatitis, Portis[15] says, "In 50 to 60 per cent of all reported cases of acute pancreatitis and in 78 per cent of our cases there were disease and presumably infection of the gallbladder."

On this particular subject, Tice[22] adds to his own observations the benefits of reviewing one hundred and sixty-seven special articles. He states: "The symptoms of all types of chronic pancreatitis are not easy to dissociate from those of chronic cholecystitis, particularly in view of the fact that one-fourth of the patients with gallbladder disease have a coassociated pancreatic lesion." Shallow *et al.*,[20] in reporting their 12 cases of acute pancreatitis, state that 8 of them also showed cholecystitis.

Perhaps the one principal factor which has to do with the association of diseases of liver and pancreas lies in the somewhat free passage of one glandular secretion into the ducts of the other organ conveying digestive fluids and infection.

The normal secretory pressure of these two glands, as given by Glasser, is bile pressure 250–275 mm. of water, pancreatic pressure 200–275 mm. of water. Concerning the relation of pancreatic duct pressure to bile duct pressure Glasser states:

> In a certain proportion of cases, the main pancreatic duct joins the common bile duct at the ampulla of Vater, and the two empty into the duodenum through a single orfice at the major duodenal papulla. It is thus possible for a spasm

* Presented at the Wheeling Hospital, Wheeling, West Virginia, June 21, 1945.

or edema of the distal portion of the ampulla or for a stone impacted in the ampulla to convert the common bile duct and the main pancreatic duct into a common channel. Since the secretory pressure of the pancreas is approximately the same as that of the liver, it is possible under these conditions for the bile to flow into the pancreatic duct or pancreatic juice to flow into the pancreatic common duct and hence to the gall bladder, depending on the pressure gradient at any particular moment.

Diagnosis of disease and altered functions of the pancreas remains difficult because of the location of the gland, its physical structure and its various symptomatology. Physiological chemistry has been the main approach to this subject for many years. Roentgen study of the pancreas and the adjacent organs has been very illuminating. Our inability to render the gland opaque with dyes has, however, limited these efforts. If the symptoms persist, even though roentgen examination gives a negative report, the pancreas should be suspected. Furthermore, Gubergrits[10] states that diagnostic difficulties arise also from the fact that a considerable anatomic destruction of the gland may not affect its function.

It becomes apparent that in the pancreas, a gland whose pathology is already difficult to interpret, any one of its functions may be interrupted by infection by way of the gallbladder, blood vessels or lymphatic channels. Ascending infection from the duodenum is a very direct route.

Sterile bile spilling over into the pancreas produces its own characteristic reaction in this gland. Then let us inquire whether any cutaneous manifestation occurs whose etiology is now unknown, when for some reason tissue digesting trypsin becomes extravasated throughout the pancreas. Again, what can be said concerning an insufficiency of any one of the allimportant external digestants—trypsin, amylopsin or lipase? When the very tissue growth and maintenance of the body is endangered, here in the pancreas it is indeed paradoxical that the skin should, in part, reflect such warning.

Concerning pancreatic insufficiency, Current Comment,[5] under title of "Abnormal secretion of the pancreas and other glands a systemic disease," has this to say: "According to Farber and his associates obstructive conditions in the pancreas early in life are associated with meconium ileus in the neonatal period and later with nutritional disturbances, in which the celiac syndrome and serious respiratory disease predominate. Farber deals particularly with the pancreas, the respiratory system, the liver and the salivary glands of young children with pancreatic insufficiency. In the pancreas he found more or less complete atrophy of the exocrine parenchyma associated with and apparently due to the accumulation of inspissated secretion in the acini and in the variously dilated ducts. In what seemed to be the early stage of the process the acini and smaller ducts contained eosinophilic homogeneous masses that would cause obstruction to the outflow of pancreatic juice as suggested by Wolbach some years ago. In such cases the duodenal contents did not give evidence of the activity of pancreatic enzyme. In the patients with the symptoms and lesions of obstructive pancreatic achylia who lived more than a few months after birth, both the lungs nearly always showed effects of obstruction of the trachea, the bronchi and the bronchioles by thick, tenacious mucoid and mucopurulent material. The mucous glands of the trachea and bronchi were distended with material like that in the pancreatic acini and ducts. That was the case also in the salivary glands and the mucous glands of the esophagus, the duodenum, the gallbladder and the jejunum. The microscopic changes in the liver duplicated in all important findings the lesions in the pancreas, even to the color and appearance of the inspissated secretions." The pancreas may be only one of many glandular structures of which the secretions are subject to physical changes of as yet unknown nature that cause obstruction and dilatation of acini and ducts, with far reaching functional and anatomic consequences. "What

has been called cystic fibrosis of the pancreas or pancreatic fibrosis is really a systemic disease with a variety of clinical appearances, the occurrence of which depends on when the obstructive changes occur and which organs are affected." Better understanding of this disease calls for studies of the nature and causes of the alterations in the glandular secretions."

When associated with A. Judson Quimby the writer joined him in a paper entitled "Roentgen findings in the upper right abdomen, with special reference to the duodenum, gallbladder and pancreas."[16] The following is a quotation from that paper:

The Roentgen and clinical findings recorded in this paper are a part of the observations made during an analysis of one thousand cases referred to us for x-ray examination of the intestinal tract. Data concerning functional phenomena in the abdomen, demonstrable by Roentgen methods, were tabulated and are submitted in the hope that special attention will be drawn to cutaneous manifestations of duodenal toxemias and the pathological and mechanical factors causing this special form of autointoxication, and that the value of x-rays in differential diagnosis of lesions of the duodenum, gallbladder, and pancreas will be further appreciated.

In recent times, we have been giving the second and third portions of the duodenum very careful consideration in our work. This has permitted us to make some observations that in some respects we regard as original, not having been able to find literature bearing directly upon this subject from the standpoint that we have observed it. This has chiefly to do with the results of delay in the drainage of the duodenum and the resulting effect upon the gallbladder and pancreas, and especially, cutaneous manifestations of duodenal toxemia. These observations have frequently permitted us to determine the existence of a pancreatitis where it was unsuspected.

Several contributors to medical literature have suggested the importance of duodenal toxemia or duodenal poisoning, but as far as we have been able to find in reviewing the subject, no attention has been given to some of the most marked clinical manifestations of duodenal toxemia. Our observations have led us to believe that the delay in the duodenum brings about organic changes in the pancreas and gallbladder, together with their drainage canals, and that serious constitutional toxemias are brought about and that one of the most marked manifestations of this poisoning is in the skin.

During the past three decades I have pursued a follow-up course concerning the pancreas and its relation to certain diseases of the skin. Observation from roentgen studies, clinical course of the cases and the result of therapeutic measures employed leads to the conclusions that (1) psoriasis is a disease of the skin due to infection of the pancreas, (2) eczema (endogenous) is due to insufficiency of pancreatic fluid.

Psorasis, considered in more detail, comprises approximately 3 per cent of all cutaneous affections according to authorities. Ormsby and Montgomery's[14] statement that "Heredity is seemingly a factor in a considerable number of cases," is not inconsistent. Frequently in this series of 25 cases of psoriasis, the history of the patient revealed some source of infectious disease, a gallbladder attack, perhaps a recent confinement, or even the administration of a vaccine.

A common channel of infection is explained in Gray's Anatomy.[9]

Glands which are found along the course of all the branches of the abdominal aorta empty into and belong to the group of pre-aortic glands. The pre-aortic glands receive vessels from the juxta-aortic glands and from all the glands along the mesenteric vessels and the coeliac axis and its branches, and receive lymph from the stomach, intestines, liver, pancreas, and spleen. They anastomose with each other.

The pelvic lymph drainage is a part of this system.

Agnes Savill,[18] a noted English dermatologist, says:

In one of my patients patches of obstinate psoriasis of the scalp and body gradually subsided without any local treatment, during a course of intra uterine ionisation and pelvis diathermy. As the profuse uterine discharge

was thus cured, the skin lesions gradually cleared spontaneously.

Physical examination of each and every patient in this series of cases of psoriasis revealed tenderness of the pancreas. For palpation the standing position is preferred. Distress is elicited by deep pressure on head of gland—symptoms diminish toward the left side of the body. I have had the opportunity of seeing a few psoriatic patients operated upon. The surgeon each time has described the pancreas as being enlarged and more dense than usual. A patient having extensive areas of psoriasis is a poor risk for surgery in the upper abdomen.

Eczema is the disease of the skin for which patients most often seek medical advice. Statistically, eczema has comprised 30 to 35 per cent of listed causes of skin diseases. So say Sutton and Sutton.[21]

The etiology at once becomes of prime importance. Ormsby and Montgomery make an interesting statement concerning heredity. Eczema, they say, "is not in itself hereditary, but a tendency to the disorder may be transmitted from parent to child, though occasionally not made manifest until adult life. Stokes states that at times there is a state of inborn tissue lability and hyperirritability that is hereditary in character. Eczema may occur in individuals who are in every respect perfect examples of health, but in many instances it is associated with some disturbance of the general economy, and it often occurs in persons who are affected with some systemic disorder."

Familial characteristic or tendency amounts to 15 per cent of the 200 cases of eczema which form the basis of this report. The history reveals that a close blood relative has diabetes or the patient himself has glycosuria or at one time sugar was found in the urine.

Having briefly considered heredity, we should next examine the subject of nourishment. Volumes have been written on foods and their relation to disease. Heretofore to no single item or class of food went the blame of producing eczema. After taking food, it is assumed that every gland and organ functions normally to digest the food. This is not true. Eczema is a disease of the skin due to pancreatic insufficiency—insufficiency of amylopsin, the principal digestant of carbohydrates. The history obtained from the majority of these patients reveals that one or more carbohydrates have been taken in excessive amounts. This fact may not be elicited in a few cases where all body functions are at a low ebb. In this series of cases amylopsin insufficiency has not been proved. However, the treatment carried out and the clinical course of the disease fully justify the assumption of this etiology.

Diet restriction is no difficult problem to have the average patient understand. Strict abstinence from *all* carbohydrates can be directed on a printed list.

Indications also point to additional diseases of the skin whose etiology is now declared unknown, but whose clinical group of symptoms is actually due to disease of the pancreas.

Dermatitis herpetiformis is an infection of the pancreas. The following is an illustrative case:

Mr. K., aged fifty-nine, a watchman, had usual health until a severe attack of hemorrhoids occurred in November, 1944. A few days later a serious and somewhat general skin eruption appeared. Itching was extreme. The correct diagnosis had been established elsewhere. An examination, in April, 1945, of this man showed typical and extensive lesions including a characteristic eruptive area overlying the sacrum. Tenderness of the pancreas was pronounced.

Treatment. The most extensive eruptive areas were given roentgen exposures. Panteric compound tablets were prescribed before meals. Lotion for itching was used freely. Sedative capsules were taken for sleep. Improvement was noted. In May, 1945, the patient was in Wheeling Hospital for penicillin treatment. During five days 120,000 units were given. The skin promptly improved and the patient was more comfortable. Pancreatic tenderness subsided. Under subsequent treatment with roent-

gen rays and pancreatic substance, improvement continued until nearly all the skin lesions disappeared. In July the patient returned to his usual work.

Carpenter and Hall[2] had the opportunity of studying 6 cases of dermatitis herpetiformis in Service men aged twenty to thirty-two years. In regard to penicillin they summarized by saying that penicillin therapy was of immediate value in the treatment of 6 patients with dermatitis herpetiformis. However, new lesions reappeared within hours to days of its discontinuance. No more benefits were derived from the use of 1,000,000 units than from 300,000, and the authors believe that 300,000 units is the optimum dose.

With uniformly good results shown in the treatment of dermatitis herpetiformis with penicillin, it would seem that panteric compound medication is second in importance. Roentgen therapy follows.

Another personal observation was made concerning the relation of the pancreas and skin:

The use of pancreatin (trypsogen) in a case of pityriasis rosea gave the most remarkable results in all my three years of experience with this glandular substance.

The patient, a middle aged workman, had pityriasis lesions from scalp to soles of the feet. At noon he was given a small dose of roentgen rays. At one o'clock he was given 175 gr. pancreatin in a glass of water. He had lunch at 2 P.M. At 6 P.M. he took 25 gr. of pancreatin before more food. At 7 P.M. the entire skin was clear. Five days later a small group of lesions appeared on the thigh. Twenty-five grains pancreatin were taken before a meal. The lesions completely disappeared. There was no recurrence.

TREATMENT

When treating diseases of the skin additional methods must be employed to meet the newer ideas of etiology.

Psoriasis in every case of the present series revealed a pancreatitis of infectious origin. The source of infection cannot always be determined. However, in some cases this can be learned and the cause eliminated.

A most helpful internal medication used has been pancreatin. Especially where accompanying involvement of the biliary tract is suspected enteric coated panteric compound tablets (which includes glycocholates and taurocholates sodium or ox gall) are used freely. Two or three tablets are recommended before meals. Diminished tenderness of the pancreas is soon noted. Colonic elimination is imperative. Local applications for removing scales have been most simple. Ordinary washing with soap will soften and remove much debris. This may be preceded if desired, by some bland oil. Stronger keratolytic action can be attained from salicylic acid in solution or ointment. Precipitated sulfur ointment is beneficial. When psoriasis with scales is present, an aqueous lotion of salicylic acid and bichloride is efficient and decidedly more acceptable to the patient than an ointment.

Years of experience in the application of roentgen rays in the treatment of psoriasis places this method as the most important of all local treatments. This fact is best expressed by Ormsby and Montgomery who say, "Radiotherapy is a clean, efficient and most valuable method of local treatment. In the majority of instances psoriatic lesions disappear with more certainty and with much greater rapidity under roentgen-rays than with any other local measure. The rays should be employed with great caution, and a dermatitis should not be induced." On the scalp roentgen irradiation is used cautiously in only the most persistent cases. Penicillin therapy combined with pancreatin remains to be tried.

"Eczema represents the outstanding province for the use of Roentgen rays in the treatment of skin diseases" (Ellinger[7]). MacKee[11] says, "The x-rays have been used successfully in the treatment of eczema almost from the very beginning of Roentgen therapy."

An over-all acquaintance with radiation therapy adds definitely to the successful

application of roentgen rays in diseases of the skin. For eczema, subery thema or semi-intensive irradiation approximates the correct dosage. Experience really shows that the dosage should vary with patients and parts treated.

Internal medication is known to play an important part in the treatment of eczema, the most common of all skin diseases. Three years ago I arrived at a conclusion that eczema is due to an insufficiency of the pancreatic gland—amylopsin insufficiency.

Concurrently with roentgen therapy, 200 consecutive cases of eczema (endogenous) without any exception have been *more* quickly cleared up and very satisfactorily controlled subsequently by the free use of pancreatin. This preparation is the ordinary pancreatic substance as produced by some of our well known pharmaceutical houses. This glandular powder is given in enteric coated tablets or ∞ gelatin capsules with water, preferably before eating. Some adults take this loose soluble powder in water just before meals. For infants the powder is always given in milk or water.

The dose of pancreatin has been found to vary considerably. Error usually lies in too small a quantity. Dosage must make up the pancreatic insufficiency or treatment will be a failure. Observation has shown no ill effects from extra large doses. Administration of 300 to 400 grains per twenty-four hours shows no particular benefit. Freshness of this glandular substance adds to its efficiency.

An infant with extensive eczema should have a heaping teaspoonful—175 gr. in the twenty-four hour diet. A remarkable change has been seen in the condition of the skin within two or three days. A smaller amount will suffice as the skin clears. Some pancreatin must be added to the child's food indefinitely. Pancreatin is administered to adults in triple strength enteric-coated tablets—two tablets with water before meals. The ordinary ∞ gelatin capsule holding 8 grains of glandular substance has been a satisfactory means of administration—three capsules with water before meals are prescribed. The number taken can later be regulated according to indications.

In recent months, benefits from pancreatin therapy have been found even more striking by giving the patient a large initial dose of this glandular substance when he comes for his first roentgen treatment. The patient is given approximately 175 gr., one heaping teaspoonful of this powder in a glass of water. Initial aid to the patient's digestion, combined with the daily pancreatin taken with meals, produces a remarkable change in the skin within two or three days. The subsequent care simply requires the proper irradiation and medication until the desired results are obtained. Some patients appear to have a permanent relief from eczema.

In many cases a recurrence of the eczema is expected because of familial reasons, personal habits, etc. Under these conditions physician and patient will learn the approximate dose of pancreatin needed to compensate for the insufficiency of the pancreas. Experience shows that 10 gr. daily, taken before the largest meal, will serve to maintain a clear skin in many cases. One adult female who had eczema for twenty years found, after we cleared up the skin with roentgen irradiation and pancreatin, that one-third of a teaspoonful of glandular substance taken in a glass of water two or three times a week would keep her free of eczema.

Local treatment of eczema has been no problem after correcting the diet and supplying the pancreatic substance. A clean and pleasant lotion of calsorcin relieves itching and is drying. If the surface becomes too dry or inclined to form small fissures during the course of treatment, the patient finds comfort in some bland ointment such as cold cream containing a little phenol. A great variety of local applications has been found unnecessary.

The anatomical distribution of endogenous eczema, as noted in these cases, is of no particular interest; however, it is note-

worthy to state here that the clinical varieties encountered in this series have all responded in a like manner to this new therapy.

Will pancreatin alone clear up eczema? Nearly all cases with this disease seek treatment when they are in great distress. Pancreatin alone has not been tried, but it is believed safe to say that this substance would relieve and control the condition, but much more slowly than when combined with roentgen irradiation. Infants are treated with only pancreatin—they are not given irradiation.

COMMENT

That there is a relationship between the pancreas and diseases of the skin was originally presented by me in 1922, under the title of "X-ray Diagnosis of Chronic Pancreatitis and its Relation to Some of the Common Skin Diseases.[17] At present there should be a closer correlation of the important points already brought out by various authors. A correlation of the anatomy, physical signs, clinical notes and therapeutic measures is very important.

Anatomy has an all-important bearing on the origin of some diseases of the skin. We should emphasize here the prime importance of the abdominal pre-aortic lymph glands and lymph vessels. In the anastomoses of these pre-aortic vessels with each other—a fact as old as modern anatomy—lies some of our neglected correlation concerning infection and skin diseases.

Physical signs revealed tenderness of the pancreas in every case of psoriasis and the one case of dermatitis herpetiformis. By way of contrast let it be understood that pancreatic insufficiency gives no physical signs.

Bullous skin conditions, represented in part by epidermolysis bullosa and pemphigus, are due to disease of the pancreas, it is suspected. Dermatitis herpetiformis is definitely known to be due to an infection of the pancreas.

Savill observed and briefly describes 2 cases of epidermolysis bullosa. She noted that the blood revealed marked hypoglycemia. Both of these cases cleared up after the administration for several weeks of large doses of glucose. Both cases had widespread erythematous vesicular rash. The temperature in one case was 99°–100° F. Pemphigus is the most outstanding bullous disease. The pathologic findings in a case of pemphigus foliaceus as reported by Schultz[19] are interesting. The principal abdominal findings were as follows: The spleen was considerably enlarged. The malpighian bodies appeared as well defined, opaque, yellowish nodules 1 to 3 mm. in diameter. The mesenteric lymph nodes were enlarged, firm and congested. The hilum of the spleen was united to the tail of the pancreas by a mass of chronic inflammatory tissue which contained enlarged lymph glands, one of which showed coagulation necrosis. With such an inconclusive autopsy report it is safe to say that pemphigus is most likely due to infection of the pancreas.

The case of pemphigus vulgaris reported by Covey[3] is of special interest because of the etiology. This patient was a female aged fifty-three. He states that in September a dentist had extracted one carious tooth and treated a rather severe pyorrhea. In November a bullous eruption appeared over nearly the whole body. The route of this infection from the gums to pancreas seems to be satisfactorily described in Gray's Anatomy. The submaxillary and deep cervical lymph vessels and glands receive lymph from mouth tissues including the gums. In part, Gray says that "Glandular enlargement is secondary to a bacterial disease or to cancer involving the lymph-vessels which come in to the gland. The seat of disease may be distant.

"Disease of the teeth, tongue, gums, floor of the mouth, and alveolar processes may cause enlargement of the glands at the angle of the jaw." "The lower deep cervical glands occasionally enlarge secondarily to malignant growths [or bacterial disease] of the abdomen or mediastinum, but this is not due to a direct flow of lymph, as the

mediastinal glands do not send vessels to the supraclavicular glands." "It is due to blocking of lymphatic vessels and reversal of the lymph stream so that lymph containing cancerous [and bacterial] disease regurgitates."

Abnormalities of the lymphatics, as referred to by Cunningham,[4] anastomoses of lymph vessels or regurgitation of contents could readily carry infection from the mouth to the pancreas.

Gonorrheal dermatoses are recognized and described in some detail by Sutton and Sutton. Internal circulation of gonococcus is troublesome and sometimes reaches serious proportions. Sutton and Sutton do not make clear the direct route of bacterial entrance into the system. The pre-aortic gland anastomoses explain the channel of infection. "Dawning's Case" as referred to by Sutton and Sutton "improved after the seminal vesicles and prostate, swollen and boggy, had been incised and drained." This occurrence is parallel with the disappearance of psoriasis after ridding a female pelvis of the infection.

Some additional comment is worth while on the three pancreatic enzymes, lipase, amylopsin and trypsin, and the insufficiency of these enzymes as a group in relation to diseases of the skin.

Xanthomatosis is principally an insufficiency of lipase to digest the fats. Under "Lipoacaic Deficiency" Moore's[13] remarks, too, convey this idea of insufficiency of the enzyme lipase. Authors generally agree that xanthoma represents disturbed fat metabolism.

Dragstedt,[6] after studying this subject, states, "It therefore may be helpful to summarize the evidence at present available which indicates that lipocaic is a specific pancreatic hormone."

"Microscopic examination shows that the histologic structure of the various types of exanthoma is essentially the same though it differs somewhat according to the clinical form which the disease assumes" (Becker and Obermayer[1]).

Eczema is a carbohydrate disease. Whether the normal carbohydrate is present in the skin in excessive amounts or a foreign carbohydrate is deposited there is not known at this time. Its presence is an irritant to the skin thereby producing eczema.

Bearing on this subject, Moore has this to say: "Of the two carbohydrates in normal tissue, glycogen and glucose, only the former is histologically identifiable. Glucose is soluble in all reagents used for the fixation of tissue, and no stain has been developed for it."

Under the subject of Diabetes, Moore again makes reference to the fact that a carbohydrate exists in the skin when he says "The epidermis in a well treated diabetic patient contains an abundant amount of glycogen, which is gradually depleted in the absence of adequate doses of insulin.

"During the past three years Pancreatin (Amylopsin) therapy, combined with radiation, has caused eczema in every patient to disappear. Control of the disease is maintained by sufficient dosage of this gland substance in like manner of controlling diabetes with Insulin."

Trypsin insufficiency is manifested in the skin by pityriasis rosea and lichen planus. Moore says that in a few pathologic conditions an abnormal protein is formed, and deposit of it in the tissue interferes with function, causing typical and at times diagnostic clinical signs. The more important one of these proteins he refers to as the substance known as amyloid. Concerning "Types of Amyloidosis," Moore divides them into four groups. Under group "(2) Primary Amyloidosis" he includes the skin among the most frequent sites involved.

While the "Pathogenesis and causal factors of formation of amyloid is still unknown," Moore favors the possibility that "amyloid or a mother substance is elaborated throughout the body and precipitated out in the organ or tissue where it is found." Among the organs where amyloid is found Moore says that lesions of the skin

appear as papules or plaque-like tumors with or without ulceration. Amyloid material has been noted at times to be of a bluish-red translucent appearance or it may transmit the color of underlying tissue, according to Moore's description.

Color of tissue produced, resulting from insufficiency of pancreatic enzymes, is worthy of note. Lipase insufficiency tissue is principally yellowish. Amylopsin insufficiency scales are white to flesh color. With trypsin insufficiency bluish to red color predominates.

In closing these comments, it may be stated that no particular reason has been encountered in embryology or physiology as to why so many pancreatic diseases are reflected in the skin. Many additional questions are in our minds concerning this organ. What happens when sterile bile overflows into the pancreatic ducts and tissue? When obstruction induces trypsin self-digestion of the gland, what disease do we find in a patient? With different bacterial infections of the pancreas, what variations of skin lesions will be seen?

CONCLUSIONS

Eczema is a disease of the skin due to insufficiency of the pancreatic enzyme amylopsin. Observations clearly indicate that disturbed carbohydrate metabolism in the skin becomes an irritant to the skin. The administration of pancreatic substance along with roentgen treatment and diet therapy has promptly cleared up all cases of eczema (endogenous). Subsequently this disease has been satisfactorily controlled by pancreatin and restricted diet.

Psoriasis is due to infection of the pancreas. As an aid to roentgen therapy, pancreatin compound is an improved medication.

Dermatitis herpetiformis, pityriasis rosea and certain other cutaneous disturbances have their origin in disease of the pancreas.

Central Union Bldg.
Wheeling, W. Va.

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TUMOR DOSAGE AND RESULTS IN ROENTGEN THERAPY OF CANCER OF THE BREAST

By MAURICE LENZ, M.D.
NEW YORK, NEW YORK

THE results of roentgen therapy of cancer of the breast vary with the dosage which reaches the tumor. This in turn is influenced by the accessibility and extent of the tumor and the tolerance to the treatment. Clinical arrest of most breast cancers by roentgen irradiation requires heavy dosage. The nearer the surface and the more localized the cancer is, the smaller is the volume of normal tissue which has to be irradiated and the greater the tumor dose which will be tolerated. Thus the growth within the breast and axillary lymph nodes may be vigorously crossfired through multiple fields and a high tumor dose may be obtained. Similar dosage is not tolerated if applied to widespread metastases.

Roentgen therapy does not remove the cancer as in excision, but destroys it in situ, leaving it to the body to dispose of the debris; it thus taxes the patient's general health. Maximum roentgen-ray dosage is not well tolerated by patients suffering from debilitating ailments such as decompensated heart disease, severe diabetes, chronic alcoholism, and so forth.

Material. In an effort to clarify the relation between tumor dosage and results of roentgen therapy, we studied the clinical histories of 206 patients with cancer of the breast irradiated with different roentgen-ray doses at the Presbyterian Hospital, New York, and some time previously, a number of breast cancers with metastases at Montefiore Hospital, New York.

Tumor Dosage of 300–2,300 r—Postoperative Roentgen Therapy. The first series of cases studied at the Presbyterian Hospital consisted of 78 patients receiving roentgen therapy after radical mastectomy between 1923 and 1929.

Within a few months and not longer than six months after radical mastectomy, the patients were given 400 r/o, 130 kv., 0.25 mm. Cu, 1 mm. Al, 40 cm. target-skin distance, each to the operated chest wall, anterior surface of the adjacent axilla, supraclavicular region and opposite axilla. This series of treatments was repeated at least once in four to eight weeks, and in some, several times at two to three months' intervals. The total roentgen-ray dosage in a year thus did not exceed 2,000 r/o. At the level of the internal mammary lymph nodes this would be reduced to a tumor dose of perhaps from 300–1,300 r and at the highest raised to 2,300 r in the region of the most superficial supraclavicular lymph nodes.

The inadequacy of this treatment may be gleaned from the fact that 8 of the cases of skin metastases occurred in a previously irradiated mastectomy area. While retrograde extension may have taken place from the periphery of the treated field, it seems more likely that the cancer cells persisted in situ in spite of this roentgen radiation dose.

The survival of the 78 patients did not seem to be influenced by the treatment as given. The clinical course following roentgen therapy varied according to the preoperative extent of involvement in the breast and axilla, exactly as in patients who had not received any postoperative treatment.

In modern postoperative roentgen therapy with 200 kv. and 0.5 to 2 mm. Cu filter, one rarely gives more than 1,500–2,500 r/o in four to six weeks to the parasternal area and 2,500–4,000 r/o to the anterior aspect of the supraclavicular region. Some also irradiate the axilla; we have not done so, as we have seen very few recurrences in this location, at the Presbyterian Hospital. Dosage in the parasternal region is reduced because of the fear of producing irradiation pneumonitis and also of injuring the poorly vascularized postmastectomy skin flap. There is a great

deal of divergence of opinion as to what such dosage can accomplish in cancer of the breast. It may be that it is sufficient to delay somewhat the appearance of skin recurrences in the mastectomy area, if cancer tissue has been left at the time of mastectomy. In the light of some studies quoted further on, however, it seems like very little dosage, indeed. In any case, it does not seem logical to consider the large dosage which may be brought to bear on the accessible breast tumor as inadequate, therefore indicating mastectomy, yet hope that the lesser dosage reaching the inaccessible metastases in the internal mammary and anterior mediastinal chain of lymph nodes will destroy metastases in these locations. Optimistic claims of the results of postoperative roentgen therapy are often based on a mistaken clinical diagnosis of persisting cancer and usually do not take into consideration the question of the dosage which reaches the site of the suspected metastasis.

Roentgen therapy after radical mastectomy at the Presbyterian Hospital is limited to cases where the preoperative estimate of the extent of the cancer has been proved inadequate by the microscopic examination of the removed breast and axillary lymph nodes, or when there is clinical evidence of persisting or recurring disease.

Tumor Dosage of 4,500 r—Preoperative Irradiation and Roentgen Therapy Alone. The second series of patients investigated comprises 82 patients with cancer of the breast treated between 1933 and 1937. Thirty-eight of these patients were irradiated preoperatively, a few days to a year prior to radical mastectomy, and 44 nonoperated patients were treated by roentgen irradiation alone. The tumor and a wide margin of adjacent breast, wherever possible, was crossfired through each of the four quadrants of the breast.

We employed 200 kv., 0.5 to 2 mm. Cu, or Thoraeus filter, 50 cm. target-skin distance, and tangential roentgen-ray beams skimming along the chest wall in order to avoid the lungs as much as possible. The treatment took about six to eight weeks. In some cases as high as, 2,000 r/o was given to each of the four breast fields and 2,000 r/o each to an anterior, posterior and direct axillary field. In most, weaker roentgen-ray dosage was administered and on the average a tumor dose of less than 4,500 r was obtained. The size of the fields varied from 8 by 10 to 10 by 15 cm., depending on the size of the tumor and the breast or axilla.

The cancer had become locally extensive in the majority of cases prior to treatment. In 47 of the 82 cases, the diameter of the primary breast tumor was 6 cm. or more, in 9 it was 3 cm. or less, in the others it varied in size between these extremes. While only 1 of the 9 small tumors failed to be markedly reduced by the treatment, this occurred in two-thirds of the larger tumors. Invasion of the axillary nodes was diagnosed clinically in all of the 82 patients and was corroborated microscopically in 31 of the 38 preoperatively irradiated patients. In 18 of the 44 (41 per cent) nonoperated patients, skeletal or lung metastases were discovered on admission, 5 others had deep ulceration of the breast, 5 had satellite breast tumors, and 17 had marked edema or fixation of the breast. It is not surprising, therefore, that only 1 of these patients survived five years. This was a patient with an operable breast tumor 2 by 3 by 2 cm. and a palpable axillary node 1 cm. in diameter, who was mistakenly thought to have skeletal metastases. She received a tumor dose of 7,100 r to the breast and 5,462 r to the questionable axillary lymph node. She was first treated in November, 1937, and was free of disease in January, 1946.

The local disappearance of the primary tumor following roentgen therapy did not influence the course of the disease in patients with distant metastases. This disappearance of the local tumor was observed more often in the more cohesively and slower growing well differentiated tumors (9 of 11) than in the more diffusely and faster spreading, poorly differentiated cancers (13 of 21) and thus, indirectly, it was a favorable prognostic sign.

Irradiation Changes. Retrogressive irradi-

ation changes were best studied in 9 breasts in which the microscopic appearance of the tumor removed at biopsy, before irradiation, could be compared with that in the specimens obtained at mastectomy, from two days to over a year after the conclusion of roentgen therapy. There were noted vacuolization, pyknosis, swelling of the cells and nuclei, atypical mitoses, reduction in the number of mitoses and sclerosis of the stroma. In spite of the large roentgen-ray doses administered to these tumors, however, recognizable tumor cells were found in all mastectomy specimens. In some breasts, in which tumor could not be seen on gross section, only a few poorly stained cancer cells were found on most careful microscopic examination of many sections. In others, which also failed to reveal tumor on gross section, islands of well preserved cancer cells were easily demonstrated. While there was some overlapping, it was clear that the larger the tumor dose, the greater was the evidence of damage to the cancer and to the irradiated normal tissues. In most cases, the interval between roentgen therapy and mastectomy was a little over a month but in 1 case in which the tumor dose was 4,500 r, it was over a year. This was the case in which the most pronounced irradiation effect was seen, as after a careful search, only 20 poorly stained cancer cells could be demonstrated. The fact that cancer persisted after a tumor dose of 4,500 r is interesting in view of Halley and Melnick's findings of primary regression followed by renewed growth, after tumor doses of 2,400–3,300 r, and Harris's demonstration of persisting cancer after tumor doses of about 4,500 r. It corroborates our belief that such doses are too low to destroy cancer of the breast completely and will produce only temporary growth restraint.

Because of the experience with this group of cases it seemed desirable to administer larger tumor doses than 4,500 r in order to obtain a more permanent clinical arrest of cancer of the breast.

Tumor Dosage of 6,000 or over—Roentgen Therapy as the Only Treatment. During 1938, 1939 and 1940, 46 patients with non-operated cancer of the breast were treated solely by roentgen therapy in an attempt to arrest the growth.

The treatment took two to three months and tumor doses of 6,000–8,000 r (in a few a little higher) were administered. To the 2,000 r/o to each of the four quadrants of the affected breast, as described for the second series, were added another 1,000–2,500 r directly over the tumor in order to raise the tumor dose to 6,000 r or more. Each axilla was crossfired with 2,500 r/o through an anterior and posterior axillary field and with 2,500–3,000 r/o through a direct axillary field. The daily dose usually was 150–200 r to two opposing breast or axillary fields. The size of the fields varied from 8 by 10 to 10 by 15 cm., depending on anatomical indications.

The difficulty of controlling axillary metastases by roentgen therapy as compared to arresting the primary tumor in the breast has been frequently emphasized. Part of this difficulty is due to the smaller tumor dose usually given to the axilla. It is difficult to deliver through three axillary fields as much tumor dosage as through four to five breast fields. For this reason the axillary fields in this series usually had to be exposed to 2,500 r/o and sometimes to 3,000 r/o. This yielded tumor doses in the axilla from 5,500–8,150 r in 9 of the 10 five year cases discussed later on and helped greatly in arresting the disease. In the tenth, the axilla was not irradiated through an error. Axillary nodes were not palpable before nor since the treatment. The patient presented a 7 cm. fungating recurrence in the inframammary fold, following a local excision and radium therapy at another hospital and has been clinically well since August, 1939, following a tumor dose to the breast of 5,500 r.

The large dosage used in these cases resulted in telangiectasia in some instances and in a few, in irradiation sclerosis. In most, however, only slight sequelae were seen which did not cause great discomfort. In 2 or 3 patients, slow healing ulcerating radiodermatitis and chronic edema of the arm resulted. Individualization and a low

daily dose helped in preventing serious sequelae.

Most of the patients had extensive involvement of the breast and axilla on admission. The breast tumors varied in size from 3 to 10 cm. Palpable axillary nodes were present in all but one patient.

Gross regression of the tumor in the breast and axillary lymph nodes did not influence the clinical course of the disease in cases in which at the time of admission or soon thereafter, there was evidence of cancer spreading subcutaneously, en cuirase, or when there were distant metastases.

Fifteen cancers of the breast were given tumor doses of less than 5,500 r, and cancer persisted grossly in all of these. Thirty-two received tumor doses of 5,500, 6,000 r or over. In only 8 of these did cancer persist locally. Of the 23 patients whose tumor disappeared clinically from the breast, 14 are dead and 9 are free from clinical evidence of cancer for over five years since roentgen therapy. Of the 14 dead, 4 died of cardiovascular disease without clinical evidence of cancer. One of these died five years and four months after roentgen therapy, thus raising to 10 those patients free from clinical evidence of cancer for over five years.

Details of the tumor doses in these 10 cases are given in Table 1.

Table I

TUMOR DOSES IN TEN CASES CLINICALLY FREE FROM CANCER FOR FIVE YEARS

Patient	*Breast Tumor* Size of Tumor cm.	*Breast Tumor* Tumor Dosage roentgens	*Axillary Lymph Nodes* Size cm.	*Axillary Lymph Nodes* Tumor Dosage roentgens
St.	8×10×4	7,600	2×2×1	6,970
Pr.	10×10×6	6,061	2×2×2	5,770
Sp.	7×3×4	5,500	0	0
El.	4×4×3	8,275	3×2.5×1.5	7,875
Ell.	3×3×2	6,325	4×5×3	8,150
McGl.	7×7×6	6,400	2×2×1	6,000
Kam.	2×3×2	7,100	5×6×3	6,700
Das.	7×7×3	7,200	2×2×1	6,000
Rob.	5×6×3	6,800	4×2×2	6,670
She.	6×5×4	5,860	2×1×1	5,625

Of the remaining 10 deaths, 3 were due to pulmonary, 6 to skeletal metastases and in 1 the cause of death was undetermined. Among the 8 in whom the breast tumor persisted grossly in spite of 6,000 r tumor dose to the breast, 4 showed cutaneous and subcutaneous en cuirasse involvement peripheral to the irradiated field. It might be speculated whether the persistence of the tumor was due to retrograde extension into the irradiated area or whether the tumor never disappeared. In 2 cases with multiple nodules, the irradiated fields definitely did not include the entire disease in the breast. One huge cancer did not change the slightest in spite of 6,000 r to the tumor.

The important fact remains, however, that with a tumor dose of about 6,000 r or over, 23 of 31 cancers of the breast, most with axillary lymph nodes, disappeared clinically, and in 10 of these, cancer could not be demonstrated clinically five years later.

We have as yet not had the opportunity to do a mastectomy five years after treatment to corroborate the absence of microscopic evidence of cancer. It may be that viable cancer cells are buried somewhere in the sclerotic depths of these breasts and that growth may some day again become active. In a patient who died of metastases seven months after her breast had received a tumor dose of 7,000 r, microscopic examination of this heavily irradiated area revealed well stained cancer cells. Grossly, the tumor had disappeared.

We, therefore, do not recommend the abandoning of radical mastectomy in cases which are operable. By radical mastectomy one may definitely cure those cases in which the entire disease is limited to the excised breast and axillary lymph nodes. Unfortunately, the frequency with which distant metastases follow this operation shows that the preoperative estimates of the extent of breast cancer are frequently inaccurate and that even the most radical mastectomy is often done too late to remove the entire disease. Only by the most rigid selection of cases for operation can mistakes be avoided.

Our criteria of inoperability at the neoplasm clinic of the Presbyterian Hospital as postulated by Haagensen and Stout are as follows:

1. When the carcinoma is one which developed during pregnancy or lactation.
2. When extensive edema of the skin over the breast is present.
3. When satellite nodules are present in the skin over the breast.
4. When intercostal or parasternal tumor nodules are present.
5. When there is edema of the arm.
6. When proved supraclavicular metastases are present.
7. When the carcinoma is the inflammatory type.
8. When distant metastases are demonstrated.
9. When any two, or more, of the following signs of locally advanced carcinoma are present
   (a) Ulceration of the skin.
   (b) Edema of the skin of limited extent (less than one-third of the skin over the breast involved).
   (c) Fixation of the tumor to the chest wall.
   (d) Axillary lymph nodes measuring 2.5 cm., or more, in transverse diameter, and proved to contain metastases by biopsy.
   (e) Fixation of axillary lymph nodes to the skin or the deep structures of the axilla, and proved to contain metastases by biopsy.

Patients presenting any of the above criteria of inoperability are referred for roentgen therapy immediately after corroboration by biopsy and are not ever operated on again, except as a palliative procedure to remove a sloughing mass, in case of failure of roentgen therapy. We do not think that an inoperable case ever becomes operable, after irradiation, in the true sense of the word.

Roentgen Therapy of Metastases. Because of the inclusion of large volumes of normal tissue, tumor doses in roentgen therapy of disseminated metastases are small and accomplish correspondingly only temporary regression or restraint of the growth. The therapeutic result depends on the location, accessibility and extent of these metastases and the local and general resistance of the patient.

Roentgen Therapy of Skin Metastases. In skin metastases, for instance, a dose of 4,500–5,000 r may be tolerated if the size of the involved area is 4 cm. or smaller. Unfiltered roentgen radiation with 100 kv. or lower voltage is commonly employed for this purpose, unless the skin nodules are along the sternal border and it is thought that they are extensions from metastases in the internal mammary or anterior mediastinal lymph nodes. In that case, 130 kv. and 5 mm. Al or 200 kv. and 0.5 mm. Cu are used. If a large area is to be irradiated, as for instance in widespread cutaneous and subcutaneous en cuirasse invasion, dosage, of necessity, is smaller. In exceptional cases even cancer en cuirasse may be controlled for a long time if the growth tends to spread slowly and if the advancing edge of the cancer can be included in the field of irradiation.

In a patient with a slowly progressing cancer en cuirasse involving the mastectomy area, the cancer was arrested for three and a half years by the administration of "7 cycles of low voltage x-ray therapy" given over a period of six months.

Most patients with extensive skin metastases, however, have usually spread so far afield when they come for treatment, that the limited area exposed to roentgen radiation does not include all of the local extensions. In most of them, skeletal and pulmonary metastases are also present so

that local regression of the skin metastasis has little influence on the survival of the patient.

Roentgen Therapy of Pulmonary Metastases. Irradiation of widespread pulmonary metastases is usually of little value as one rarely gives more than 1,000–2,000 r and as the process in most cases has already spread beyond the irradiated area. Significant regression of pulmonary metastases is observed chiefly in cases in which the involvement is limited to the periphery of one lobe and where tumor doses of 2,000–2,500 r will be tolerated.

Roentgen Therapy of Liver Metastases. Because of low tolerance in the region of the liver, roentgen therapy of hepatic metastases is limited to a tumor dose of a few hundred roentgens, to perhaps 1,000 r. This results in a slight reduction of pain and in the size of the metastases. Liver metastases in cancer of the breast occur chiefly in the terminal stage of the disease and usually mean death within a few months.

Roentgen Castration and Skeletal Metastases. Relief of pain and recalcification of skeletal metastases are often obtained by producing an artificial menopause with a tumor dose of about 600 r to the ovaries. We recommend this treatment only in patients with cancer of the breast who have evidence of distant metastases. We do not use it routinely otherwise. We also do not think it logical to administer roentgen treatment to the ovaries in patients past the menopause.

Roentgen Therapy of Skeletal Metastases. Irradiation of the ovaries should not be relied on solely to take care of skeletal metastases, but, in addition, painful areas should be irradiated directly. In widespread skeletal involvement it is not possible to irradiate all metastases. Total body irradiation is limited to about 300 r as shown by experience in cases of Hodgkin's disease and lymphosarcoma. This certainly is insufficient to destroy cancer of the breast. If there are several moderately sized metastases, each may be given 1,000–1,500 r for relief of pain. On the other hand, if only a single metastasis is evident, much higher dosage may be administered and a more prolonged growth restraint obtained:

A tumor dose of 2,500 r to a collapsed eighth dorsal vertebra caused this to recalcify. This remained the only metastasis for eight years, permitting attention to household duties, driving a car, etc., in a patient who had had a radical mastectomy four years previous to the involvement of the spine.

Involvement of the brain and spinal cord are mostly extensions from or compression by skeletal metastases. They usually occur in the terminal stages of the disease, and though temporary regression may be obtained by doses of 1,000–2,000 r, the gain is only slight since the patients die within a few months from generalization of their metastases.

Natural Clinical History of Untreated Cancer. In irradiation of widespread metastases, some metastases usually remain untreated, either because the patient is unable to tolerate the treatment, or as the metastases are not recognized. For instance, breast cancers tending to grow rapidly and spread diffusely may not be started on treatment until after the occurrence of unrecognized and therefore untreated metastases. It must be assumed that skeletal and pulmonary metastases after radical mastectomy occur before the removal of the source of these metastases, i.e. the primary breast tumor and axillary lymph nodes. The clinical course after roentgen therapy in widely extending or metastatic cancers does not depend so much on the tumor dosage reaching any particular part of the neoplasm as on the inherent growth tendency of the untreated disease and the natural resistance of the patient to this growth. Adequate tumor dosage is more important in breast cancers with a tendency to chronic and localizing growth which may be treated, while the cancer is still confined to the breast and axilla, thus making the entire disease process accessible to roentgen therapy. Among patients with untreated cancer of the breast, 80 per cent die within

five years after the appearance of the breast tumor, while 20 per cent survive this period though they may still have clinical evidence of cancer. Five year survival after roentgen therapy in patients belonging to the latter group is of little significance whereas it is an important accomplishment in patients belonging to the 80 per cent, who, if untreated, would die within this period.

One of our patients irradiated for painful skeletal metastases had avoided all doctors for twenty-two years after she had been told that she needed a radical mastectomy, Had she had either surgery or irradiation, she might have been reported four times as a five year cure.

The better results of radical mastectomy in the more cohesively and slowly growing well differentiated cancers of the breast, as compared to the more diffusely and more rapidly spreading undifferentiated cancers have recently been re-emphasized by Haagensen and Stout in their study of 547 cancers of breast operated on at the Presbyterian Hospital. Of 53 well differentiated breast cancers 84.9 per cent were free from clinical evidence of cancer at the end of five years. Corresponding proportions for 170 partly differentiated cancers were 67.1 per cent and for 224 undifferentiated, only 28.1 per cent.

This tendency to grow more slowly may continue even after the appearance of skeletal metastases. Thus, the interval between the appearance of the breast tumor and the skeletal metastases, and from that time to death, was longer in patients with cancer of the breast graded 1, as compared to those graded 3, in an investigation of 57 such patients treated at the Montefiore Hospital, New York, and reported with Freid.

SUMMARY

The influence of tumor dosage on the clinical results of roentgen therapy of cancer of the breast has been emphasized by an analysis of the histories of 206 patients treated at the Presbyterian Hospital, New York, and a number of metastatic cases treated at the Montefiore Hospital. The administration of a tumor dose of 5,500 r or more within three months has caused the clinical disappearance of the breast tumor and enlarged axillary lymph nodes in 24 of 32 patients (1 treated in 1937). Eleven of these 24 cases in whom the disease, though inoperable (1 operable), appeared limited to the breast and axillary lymph nodes, or about one-third of the 32 patients receiving this dose, were free from clinical evidence of cancer five years after roentgen therapy.

It is possible that, in spite of this clinical result, viable cancer cells may be locked up in the sclerotic depths of these heavily irradiated breasts and that at some time they may again start to grow actively. In 8 of 32 cases tumor persisted grossly in the breast in spite of this dosage. We therefore do not suggest substitution of roentgen therapy for radical mastectomy in strictly operable cases. There is no doubt, however, that many radical mastectomies are done on patients with locally inoperable tumors, though the disease appears to be confined mainly to the breast and axillary lymph nodes. It is these cases which should be treated by roentgen therapy in preference to the less inclusive radical mastectomy. Regression of an adequately irradiated portion of a cancer does not affect further progress of other portions of the growth which are under-irradiated or untreated. Thus 9 of the 32 patients died with pulmonary or skeletal metastases in spite of the local clinical disappearance of the breast tumor.

The administration of an average tumor dose of 4,500 r may cause marked irradiation changes in the cancer yet microscopically viable cancer cells may be demonstrated in the breasts removed at mastectomy as long as one year after treatment.

Still smaller dosage such as applied to metastases or given postoperatively may restrain the growth of the irradiated cancer temporarily, but is certainly too weak to destroy breast cancer. In these cases, the natural clinical history of the untreated

cancer influences the clinical course after roentgen therapy.

Tolerance of adequate tumor dosage is influenced by the extent of the cancer, its natural growth tendency, its location and accessibility, local radioresistance of the irradiated normal tissues and the ability of the patient to support the treatment.

CONCLUSIONS

A study of the relation of tumor dosage to the clinical results in 206 patients receiving roentgen therapy for cancer of the breast at the Presbyterian Hospital from 1923 to 1940, and a number of others with distant metastases treated at Montefiore Hospital leads us to the following conclusions:

1. For cancer clinically confined to the breast and axillary lymph nodes, radical mastectomy is the treatment of choice unless there are present any of the criteria of inoperability as described. In the latter cases, it is preferable to use roentgen therapy with tumor doses above 6,000 r to the breast and axilla. Strict separation of breast cancer apparently confined to the breast and axilla into operable and inoperable cases, and treatment of inoperable cases only with roentgen irradiation, is preferable to temporizing with mastectomy plus preoperative or postoperative roentgen therapy.

2. Smaller tumor dosage applicable to supraclavicular and other metastases may result in temporary growth restraint but not in destruction of breast cancer.

180 Fort Washington Ave.
New York, N. Y.

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PRIMARY MALIGNANT BONE TUMORS*

A REVIEW OF CASES SEEN IN THE RADIATION THERAPY DEPARTMENT OF BELLEVUE HOSPITAL

By RIEVA ROSH, M.D.
Radiation Therapist, Bellevue Hospital, Instructor of Surgery, New York University Medical School,
NEW YORK, NEW YORK
and
LOUIS RAIDER,† M.D.
Trainee of the National Cancer Institute
WASHINGTON, D. C.

DURING the past twenty years 235 cases of primary malignant bone tumor were seen in the Radiation Therapy Department at Bellevue Hospital. At their initial appearance, the patients presented themselves with varying stages of disease, from very early to terminal. Of the 235 cases, 114 were too far advanced for any treatment. In this paper we will be concerned with the remaining 121 treated cases.

There has been a great deal of confusion as to the terminology and classification of bone tumors. However, with the establishment of the Commission of Registry of Bone Sarcomas of the American College of Surgery, standards were set which are generally accepted and which we will follow in this presentation. All of our cases were distributed among the following groups:

1. Osteogenic sarcoma
2. Chondrosarcoma
3. Endothelioma
4. Multiple myeloma
5. Giant cell sarcoma

Table 1 illustrates the number and percentage of each type of case.

The different types of bone tumor vary in their response to irradiation. In order of radiosensitivity they are, endothelioma, multiple myeloma, giant cell sarcoma, osteogenic sarcoma, and chondrosarcoma.

The value of radiation therapy in the treatment of primary malignant bone tumors has been a controversial subject. It is true that rarely, even in the most sensitive type of tumor, is a permanent cure effected by irradiation. Moreover, in the more resistant types there is little appreciable change. Despite these facts, the opinion is being expressed more and more frequently from authoritative sources that the best hope of cure for patients lies in the combination of intensive radiation therapy and surgery. This has been our impression, and experience has borne out its veracity.

TABLE I

DISTRIBUTION OF MALIGNANT TUMORS ACCORDING TO CLASSIFICATION

Type of Tumor	No. of Cases	Percentage
Osteogenic sarcoma	45	37
Chondrosarcoma	8	07
Ewing's tumor	32	26
Multiple myeloma	18	15
Giant cell sarcoma	18	15
Total	121	100

The following is a brief outline of the procedure followed in working the treatment of a patient. First, a case history is taken and physical examination is made. Special attention is given to the duration of symptoms or signs, the presence or absence of pain, whether a mass is palpable, and if so, the rate of growth, whether or not trauma preceded the onset of disease, and whether previous treatment had been given. A careful laboratory study is done. Urine

* From the Radiation Therapy Department, Bellevue Hospital, Dr. I. I. Kaplan, Director. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.
† Now on active duty with the Army of the United States.

is examined for Bence-Jones protein. Blood studies include complete blood count, Wassermann test, sugar, calcium, and sedimentation rate. All indicated roentgen examinations are done; including studies of the local area and all sites of possible metastases.

When these preliminary studies are done, biopsy is considered. Often a conclusive diagnosis is established without pathological examination. However, when there is doubt, we believe that biopsy should be done. In some cases a limb may be saved and therapy instituted for a nonmalignant condition. When the presence of a malignant tumor is confirmed, intensive radiation therapy is given, and if the tumor is accessible amputation of a limb or radical excision is done.

The technique of irradiation varies with the individual case. In an extremity where amputation is to be done, the skin is disregarded over the local area and high voltage therapy is given, cross firing through fields extending well beyond the margins of the tumor. Where immediate amputation has been contemplated, dosage as high as 4,000 r per field, treating each of two fields with a dosage of 300 r per day. In tumors of bone where surgery cannot be done the parts are treated by fractional high voltage roentgen irradiation to skin tolerance. Similar treatment is administered to the regional lymph nodes and metastatic areas when detected. When the skin has recovered, allowing an interval of two to three months, therapy may be repeated to skin tolerance. In the average individual, depending upon the size of field and the individual reaction of the patient, the tolerance will be 2,100 to 3,000 r per field.

OSTEOGENIC SARCOMA

Osteogenic sarcoma has its origin in cells which are the precursors of normal bone, the osteoblasts. There are two chief types, the sclerosing osteogenic sarcoma and the osteolytic osteogenic sarcoma. Histopathologically, they may consist of round cells, spindle cells, or a combination of both. Giant cells are frequently present. However, in contradistinction to giant cell tumor, the giant cell does not predominate.

The majority of patients were under twenty years of age. However, there was a surprisingly large group who developed the osteolytic type of sarcoma at a later age. These often ran a more benign course, as did Case 1. The usual case is one with less than one year's history of pain and swelling. Often a pathological fracture occurs. If untreated, the patient dies within a year. An early case with an accessible tumor stands about a 25 per cent chance of cure if amputation is done. Others may have their lives prolonged.

In our series there were 45 cases of osteogenic sarcoma. It will be noted that the number of cases and patients over forty years of age was high. The incidence of osteogenic sarcoma per decade is noted in Table II. Most of our patients showed

Table II

AGE INCIDENCE OF OSTEOGENIC SARCOMA

Age Years	No. of Cases
0–20	22
20–30	5
30–40	3
Over 40	18

evidence of metastases and received only irradiation. Those who showed no evidence of metastatic lesions were treated either by amputation or excision, combined with irradiation. Coley's serum was used in many cases, but we could see no appreciable difference in our results. The results are outlined in Table III.

Case 1. This is an example of a patient with the osteolytic type of osteogenic sarcoma who survived eleven years with radiation therapy alone. J. B., female, white, aged twenty-six, was admitted on February 9, 1931, with a fracture of the left femur. She stated that during March, 1930, in the third month of her third pregnancy, she had developed pain in her left thigh. A private physician roentgenographed this area and told her that she had a defect in her femur which was common in pregnant women. She was permitted to carry to term. Three weeks post partum, the patient sustained a fractured

Fig. 1. Case 1. Osteogenic sarcoma. *A*, appearance at time of admission, showing destructive lesion of the upper third of left femur. *B*, following radiation therapy, showing regeneration of bone.

left femur and was put into a spica cast. Six weeks later, when there was no evidence of regeneration of bone, she was referred to Bellevue Hospital. At the time of admission, roentgen examination revealed a destructive lesion of the upper third of the left femur. The cortex was eroded and only spicules of bone were present at the site of pathology (Fig. 1 *A*). Biopsy revealed a spindle cell sarcoma containing many giant cells. Because of the location of the tumor, radiation therapy was instituted, together with Coley's serum. By July, 1931, sclerosis was perceptible, and subsequently progressed to almost complete regeneration (Fig. 1 *B*). In September, 1931, a chest roentgenogram revealed two rounded areas of increased density in the right lung, one in the first anterior interspace and the other at the cardiophrenic angle. Radiation was given to these areas and to the primary site of tumor. For the next five years the patient was comfortable. Two inches of shortening of the left thigh caused her to walk with a limp. In January, 1936, she returned, complaining of shortness of breath. A chest roentgenogram revealed a dense circumscribed mass in the mediastinum extending from the upper border of T_5 to the lower border of T_{10}. This lesion disappeared under high voltage roentgen therapy. At the same time the left thigh was irradiated. She remained well until February, 1941, when she returned complaining of respiratory distress and an open draining sinus

Table III

Survival Rate of Patients with Osteogenic Sarcoma

Form of Therapy	No. of Cases	5 years	3 years	1 year
Amputation and irradiation	3	1	2	0
Excision and irradiation	14	4	4	6
Irradiation alone	31	1	0	30
Total	48	6	6	36

over the original lesion. At this time a chest roentgenogram revealed extensively disseminated metastatic nodules throughout both lungs. Therapy was instituted over the chest, but was of no avail. The patient died on May 20, 1941, more than eleven years after the onset of her first symptoms.

CHONDROSARCOMA

Chondrosarcoma is a malignant bone tumor, the predominating tissue of which is cartilage. There are two types, primary and secondary chondrosarcoma. The former arises in the periosteum without apparent antecedent tumor. The latter arises in a previously existing chondroma or osteochondroma.

Primary chondrosarcoma or chondromyxosarcoma is a highly malignant tumor which arises in the periosteum at the site of a tendon insertion, most frequently about the knee. The usual history is one of gradually increasing pain and swelling in a patient over twenty years of age for a period of five or six months. Roentgen examination shows little evidence of bone destruction early in the course of the disease, only a faintly visible subperiosteal shadow being present. It is one of the most malignant of the bone tumors, and even with irradiation and amputation the average patient dies of metastases within a year after treatment is instituted.

Secondary chondrosarcoma arises in a previously existing chondroma, osteochondroma, or Paget's disease in a patient over thirty years of age. Usually there is a history of a long standing asymptomatic tumor which suddenly enlarges and becomes painful. Trauma is often an antecedent factor.

The roentgen picture is characteristic, having a mottled appearance resulting from a large cartilaginous tumor containing areas of ossification. The margins are indistinct and blend with the soft tissues. The antecedent benign tumor can be detected within the mass. Late in the course of the disease the cortex and medulla of the bone may be involved.

Treatment in these cases is like that of an osteogenic sarcoma: intensive irradiation, followed by amputation wherever possible. Where amputation cannot be done, excision and irradiation are advisable.

There were 8 cases of secondary osteochondrosarcoma in our series. Three were between twenty and thirty, 3 between thirty and forty, and 2 over forty. Three of these 8 cases survived more than five years. One of these 3, and the other 5, died of pulmonary metastases. The results are recorded in Table IV.

TABLE IV

SURVIVAL RECORD OF PATIENTS WITH CHONDROSARCOMA

Type of Treatment	No. of Cases	5 years	3 years	1 year
Amputation and irradiation	3	2	0	1
Excision and irradiation	3	1	0	2
Irradiation alone	2	0	0	2
Total	8	3	0	5

The following is an example of a patient who survived seven years under treatment consisting of the combination of excision and irradiation.

CASE II. W. C., a white male, aged twenty-seven, was admitted on October 10, 1931, complaining of a painful tumor of the right thigh. In October, 1929, he had fallen 6 feet, landing upon and injuring the area which was now painful. He was sore for a day or two, and then the pain subsided. Two weeks later the area again became painful, and he noticed a mass which appeared to be increasing in size. At the time of admission, a hard, nontender mass about 15 cm. in diameter was noted in the upper portion of the right thigh, extending medially into the buttock. Flexion of the thigh was limited. Laboratory findings were negative. Roentgen examination revealed a large osteocartilaginous tumor extending medially and posteriorly from the neck of the right femur (Fig. 2). On October 29, 1931, excision was attempted, but could not be done completely. Pathological diagnosis at that time was osteochondroma.

Within one year there was evidence of recurrence and extension. Deep roentgen therapy

was given. The patient did well until January, 1937, when he returned with a large tumor mass in the thigh and gluteal region. A roentgenogram showed extensive recurrence, with a loss of the previously present line of demarcation of the tumor and destruction of the head of the femur (Fig. 3). Surgery was attempted, but excision could not be completed. The pathology was reported as osteochondrosarcoma. Additional radiation therapy gave little relief, and the patient died two months later.

EWING'S TUMOR

Ewing's tumor comprises a group of highly malignant endothelial sarcomas which arise in the shafts of long bones in patients during the first two decades of life. The tibia and femur are most frequently involved, but any bone of the body may be affected. The epiphysis is never primarily involved, and only rarely secondarily.

The tumor is thought to arise in the lymphatic channels of the bone. It extends longitudinally along the shaft, expanding

Fig. 2. Case 11. Original roentgenogram showing osteocartilaginous tumor, the margins of which are still intact.

Fig. 3. Case 11. Chondrosarcoma, appearance at last admission, showing extension into soft tissues and destruction of bone.

it, and later invading the medullary cavity. The tumor cells do not form bone, but reactive bone is formed subperiosteally. Microscopically, the tumor is made up of rounded or closely packed polyhedral cells, with rounded or oval nuclei and a small amount of clear cytoplasm. The history in the usual case is one of a gradually increasing painful tumor, often following trauma. The duration of symptoms may be anywhere from two months to one year before diagnosis. A generalized reaction may include fever, leukocytosis, anemia, and general debility. The roentgen picture is characteristic, consisting of fusiform widening of the shaft of the bone with successive layers of periosteal calcification extending in parallel fashion for a considerable distance along the shaft of the bone. The outermost layers end free in the soft tissues, giving an incomplete appearance. Bone destruction is absent, and

because of the periosteal ossification there is a generalized increase in density of the affected area.

Ewing's tumor metastasizes early and rapidly. The sites most frequently involved are the lungs, the regional lymph nodes, and, unlike other malignant bone tumors, the skeletal system.

TABLE V

EWING'S SARCOMA

Alive	3 yr.	1 yr.		Total
Excision and irradiation	3	5		8
Irradiation	1	3		4
Amputation and irradiation	4	6		10
Irradiation not completed			10	10
Total				32

Endothelioma is the most radiosensitive of bone tumors. When there is doubt as to the diagnosis, a course of radiation therapy may be used as a therapeutic test, so rapid is the response. However, the likelihood of a permanent cure with irradiation alone is small. The treatment of choice is the combination of radiation therapy and amputation where an extremity is involved, or excision where other bones are involved. Even with the best of treatment, the prognosis is poor, since only 10 per cent or less of cases are permanently cured.

There were 32 cases of Ewing's tumor in our series. Twenty of these patients were under twenty years of age, 6 were between twenty and thirty, 3 between thirty and forty, and 3 older than forty.

Only 1 of our patients has survived and been observed for over five years. The others who were first seen more than five years ago have either died or been lost track of before the five year period was over. Several have been under observation for three years (Table v). The following case is an example of an early lesion treated with intensive radiation therapy, followed by amputation, which has survived three years.

CASE III. B. G., a white male, aged nineteen, came to our department complaining of pain and swelling of the left elbow of three months' duration. He had been examined at an induction station and rejected because of a lesion in this area. A roentgenogram revealed irregularity and periosteal proliferation of the lower end of the shaft of the humerus (Fig. 4). A diagnosis of Ewing's sarcoma was made and confirmed by biopsy. There was no clinical or roentgen evidence of metastases. Intensive roentgen therapy was given over the elbow through several fields, and the left axilla was irradiated to skin tolerance. When this course was finished, the appearance of the bone had returned almost to normal. On April 21, 1942, a disarticulation of the left shoulder and a dissection of the left axilla were done. The patient had a stormy postoperative course, but recovered. He showed no evidence of metastases on a recent examination.

MULTIPLE MYELOMA

Multiple myeloma is an invariably fatal condition characterized by multiple simultaneous punched out areas occurring most frequently in the spine, ribs, skull, pelvis, and upper portions of the femurs. The hemapoietic tissues are affected, the histopathology being of three types—the myelocytic, the plasmyocytic, and the lymphocytic myelomas.

The average age of patients with this tumor is fifty or over, with few patients under forty years of age. Clinically, the disease is characterized by generalized weakness, rheumatic pains, and skeletal deformities, including vertebral collapse, which may result in radiculites and even paraplegia. Pathological fractures occur in more than half the cases and may be the presenting feature. A nephrotic picture is present in the majority of cases characterized by Bence-Jones protein in the urine.

The roentgenologic appearance is characterized by rounded or oval punched out areas of osteoporosis with no reaction in the surrounding bone.

There is no surgical treatment that is satisfactory. Radiation therapy often gives remarkable palliative results. Pathological fractures heal more rapidly and symptomatic relief is obtained. However, the disease progresses and the patient dies

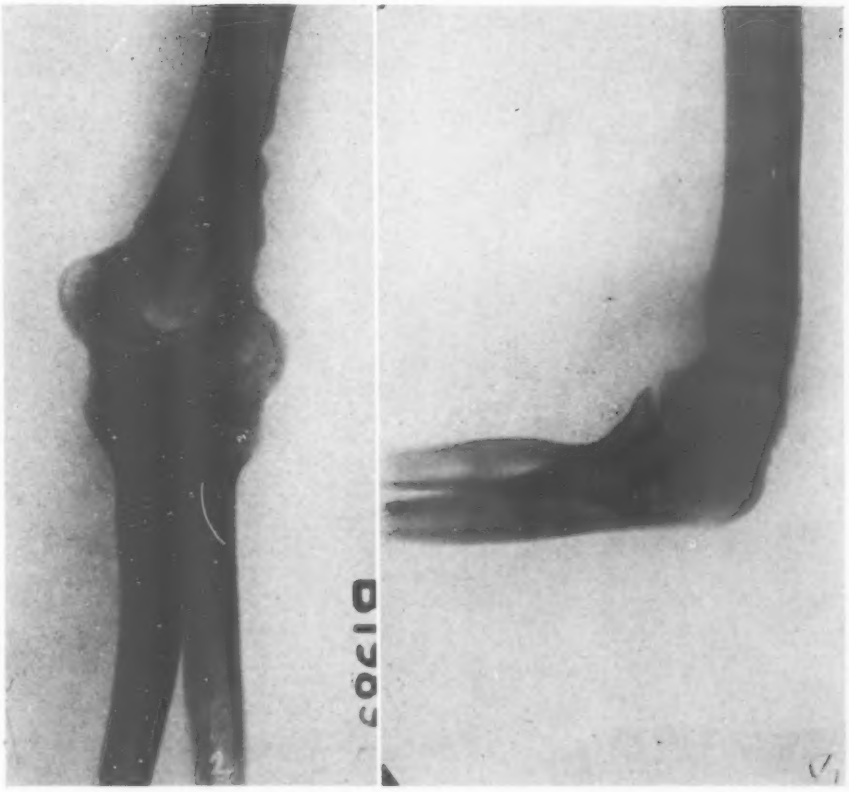

Fig. 4. Case III. Ewing's tumor, showing periosteal elevation and erosion of the cortex.

within a year or two, rarely surviving five years.

There were 18 cases in our series. Of these, 8 died in one year, 3 during the second year, and 7 lived three or more years. The following patient survived four years:

Case IV. N. R., white male, aged forty-four, was admitted to Bellevue Hospital on December 3, 1932, complaining of pain in the chest and head, weakness, and inability to walk. Roentgen examination revealed multiple rounded expanding lesions in several ribs, the skull, and pelvis (Fig. 5). The urine was strongly positive for Bence-Jones protein. Several of the dorsal vertebrae were collapsed. Deep roentgen therapy given over the affected areas with a marked recovery of motor function and relief from pain. During the next four years he returned and was treated symptomatically. During 1936, however, he became refractory to treatment and died.

GIANT CELL SARCOMA

Giant cell sarcoma, also known by a variety of names, including osteoclastoma, myeloid sarcoma, and solitary myeloma, has the same age and anatomical distribution as benign giant cell tumor. It occurs in the ends of long bones of young adults, involving in order of frequency the lower end

Fig. 5. Case IV. Multiple myeloma, skull showing multiple punched out areas.

Fig. 6. Giant cell sarcoma. *A*, left shows destructive lesion expanding the bone with dissolution of cortex medially. *B*, same case, six months later following radiation therapy, shows regeneration of bone.

of the radius, tibia, or femur, and the upper end of the tibia. Some appear to be malignant from the onset, while others become malignant following repeated curettage. Several authors report an average of 20 per cent of malignant tumors among giant cell tumors.

The clinical picture varies. Sometimes pathological fracture is the first indication of the condition. More often there is a history of pain and swelling in the region of a joint, frequently following trauma. It may grow rapidly and extend to a pathological fracture in from two months to a year.

The roentgen picture in the early stage is indistinguishable from that of benign giant cell tumor. One sees a cystic tumor at the epiphyseal end of a long bone or in the jaw, traversed by trabeculae with no peripheral reaction. This expands to leave only a shell of bone which likewise subsequently is dissolved (Fig. 6*A*). There may be some periosteal reaction at the junction with the adjacent bone. Metastases occur to the lung and regional lymph nodes.

Though less radiosensitive than either Ewing's tumor or multiple myeloma, this is the tumor in which radiation therapy gives the greatest percentage of cures. There are several courses of therapy which have been followed by various workers. Good results have been reported with amputation, curettage, curettage and bone chips, excision and irradiation, or irradiation alone. Brailsford advocates the last. Our impression is that excision and irradiation is the most desirable combination. Following radiation therapy there may be

an initial extension of the tumor, but this is followed by sclerosis and often complete regeneration of bone (Fig. 6*B*).

There were 18 cases of giant cell sarcoma in our series. Of these, 8 failed to return following the first course of therapy. Of the remaining 10 cases, 6 had excision and radiation therapy. Four were alive and well three years later, and 2 had died during the first two years. Four patients had radiation therapy alone. Three of these were alive and well after three years, and the fourth had died of metastases.

DISCUSSION

The outlook for the patient with a malignant bone tumor is no longer hopeless. Early recognition followed by aggressive treatment with the least possible loss of time offers a good chance of permanent cure. Many patients have a long happy and useful life despite the loss of a limb incident to cure. With universal efforts toward educating the public and general practitioner to the early signs of malignant disease, it is hoped that a greater percentage of cases will be diagnosed early and cured.

The rôle of the radiation therapist is becoming more important. As a tumor specialist, he is often consulted regarding diagnosis and the courses of therapy. When diagnosis is made, he is more frequently called upon to give preoperative and postoperative radiation therapy. In the cases with metastases, irradiation offers the best hope of palliation.

SUMMARY

1. One hundred and twenty-one cases of primary malignant bone tumors seen in the Radiation Therapy Department have been reviewed.

2. A procedure in treating patients with malignant bone tumors has been outlined.

3. Each class of tumor has been treated separately.

4. Illustrative case histories of the various types of tumor are given.

5. The rôle of the radiation therapist is evaluated.

Rieva Rosh, M.D.
1120 Park Ave.
New York, N.Y.

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Rieva Rosh, M.D.
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DISCUSSION

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seen in a large general hospital, especially a city hospital where all types of cases are seen.

The radiotherapist is faced with two possibilities in such cases: first, cure; second, palliation.

As to cures, we are forced to admit that our percentage of successes is going to be very low, though we find some consolation in the fact that surgery, also, has little to offer. In our choice of therapy, therefore, not only must we consider the possibility of obtaining a fair percentage of cures, but we must take into consideration any possible unfavorable effect on the patient.

As is shown in Dr. Rosh's chart, her best results were obtained by a combination of surgery and irradiation. I believe that this is true generally. Certainly it has been true in our own series.

Benign giant cell tumors, of course, call for irradiation if we can exclude malignant variants or those which will later undergo malignant change. In our series, presented a few years ago, we had one case which, following all possible diagnostic procedures, was treated as a benign giant cell tumor. Unfortunately during the course of radiation therapy, evidences of malignancy developed, and biopsy showed it to be a fibrosarcoma.

In nearly all cases of malignant variants of giant cell tumor, with metastasis, the pathology is that of osteogenic sarcoma. Ewing's sarcoma, in our experience, is sensitive to irradiation, but it may metastasize rapidly and we have had no good permanent results.

I would like to say a word about a case I reported some years ago—a tumor of the clavicle with a pathological fracture, which on biopsy was diagnosed as osteogenic sarcoma. We treated with roentgen therapy plus fever therapy and obtained an excellent result. The patient is still working and there has been no evidence of recurrence. I do not present this as a case cured by fever therapy but I believe it is an indication that such combined treatment should be considered. I have no other cases with so long a survival period.

As to the palliative effects of treatment, we have to consider first the relief of pain, which means much to the patient. The growth of the lesion may be checked and life may be prolonged. It is my opinion that patients with malignant bone tumors will live longer with radiation therapy than they will following surgery, though I cannot say that they will live with less morbidity.

DR. H. S. SHOULDERS, Nashville, Tenn. I am glad Dr. Doub told you about a case. Those of you who were at San Francisco at the meeting of the Radiological Society of North America heard a presentation of some experimental work that we have been doing over a period of years with the combined method of treatment, namely, fever and roentgen therapy.

I cannot give you the full data at the present time. I hope in the next year or two to be able to do so, but we are definitely convinced that in treatment of sarcoma there is a definite field for the combination of fever and roentgen therapy. We are sure that we are getting results far beyond any other method that we have tried. I want to bring it to you in detail at a later date.

I was the one who asked Dr. Doub about his case that came up several years ago and which he reported in the literature. Those of you who have sarcoma that you can't do anything with (the surgeon doesn't want them) please try to get a fever therapist to help you out. And don't be discouraged with one case. We have treated a number of cases and tried it once, twice or three times, and I believe you will be surprised at the results.

I am not telling you that we have cured them. We started in absolutely with the supposedly hopeless cases. So far our results are rather amazing.

DR. ROSH (closing). The question has been asked: "Reference was made to the use of Coley's serum. Is it a new preparation?" No, it isn't. Dr. Bradley Coley worked on a serum over fifty years ago at Memorial Hospital. He first published his work on Coley's toxins in 1893 and 1894. After Dr. Coley, Sr. died, his son continued work together with Dr. Norman Higinbotham at Memorial Hospital. They are still working on it and claim some results.

I merely refer to our series of cases at Bellevue Hospital. We have treated some of these patients when we were able to get the serum. It was put out commercially by Parke Davis & Company about the year 1900. On one of the surgical divisions of Bellevue Hospital where Dr. Norman Higinbotham is on the staff, he brings in the preparation from Memorial Hospital and we treat the patient with it in conjunction with radiation therapy; but, as I mentioned in the paper, I feel that there is no marked difference from the injection of Coley's serum in the final outcome of relieving or curing the patient.

RECOVERY FROM RADIATION MUTATIONS OF THE GENES

By WILLIAM SNOW, B.S., M.D.
Roentgenologist-in-Charge, Harlem Hospital; Director of Radiology, Bronx Hospital
NEW YORK, NEW YORK

THE effects of roentgen irradiation can be divided into somatic and genetic. Somatic effects were recognized by the early pioneers in radiology. They themselves received roentgen injuries especially of the hands and face. Some had such severe damage and pain that removal of fingers, extremities, and even eyes had to be performed. It was discovered that tissues had different sensitivity to irradiation. Short-lived cells such as lymphocytes, leukocytes, and spermatozoa are more sensitive, and muscles or mature nerve cells are more resistant. Generally, cells highly active and of more independent metabolism are more readily affected. Thus it is possible to destroy some tissues while at the same time neighboring structures receive little or no harm. In other words, there seems to be recovery of cells from minimal roentgen injury. It is important to keep this in mind.

SOMATIC EFFECTS

With the use of the roentgen ray for diagnostic purposes it is fair to assume that the amounts of energy employed are extremely safe as far as the somatic tissues are concerned. When roentgen rays were first used, single coated glass plates and gas roentgen tubes were employed. This often required long exposures which were not accurately controlled. Tissue injury could and did occur. Roentgenologic technique is improving all the time. A double coated roentgen film is now in use. Since its introduction it has been given greater and greater sensitivity thereby shortening the roentgen-ray exposure. The same can be said for the intensifying roentgen-ray screens. Today only a small fraction of the energy of the early days is required for the same roentgenologic study. What is more, it is safe to say that this will probably be reduced to even a smaller fraction in the future.

The rapidly growing fetal cells are sensitive to roentgen exposure; 450 roentgens delivered into the uterus will usually cause fetal death in early pregnancy. In fact, this is an accepted method for inducing abortion. In order that this treatment shall not result in failures the exposures have been increased to 600 r. As a result all manner of defective structures of the fetus develop, particularly changes of the nervous system and eyes. Douglas Murphy has made an extensive study of the harmful effects of roentgen irradiation of the fetus. He emphasizes the danger of giving roentgen treatments for fibroids in the presence of a fetus in utero. This is particularly important because fibroids tend to become very large during such a time so that they may overshadow the pregnancy. Since the dosage applied under such conditions usually runs between 400 to 600 r delivered to the uterus and ovaries, the chances are that the fetus will die. However, if, let us say, 200 to 300 r is given and then the treatment is stopped because a pregnancy is discovered, it has actually happened that the mother has given birth to a live baby. Such offspring are likely to have mental and physical deficiencies.

With the roentgen-ray technique used today for diagnostic purposes during pregnancy from 1 to 2 r per film reaches the uterus. Frank Liberson (personal communication) made such measurements with the ionization chamber actually in the vagina during the exposures. By using speed developer we have been able to reduce the required energy about one-third. As a result, for a four film pregnancy study we deliver about 5 r into the uterus.

This appears to be safe within a wide margin. No recognizable change in the babies has been noted in over 4,500 pregnancy cases that we have roentgenographed in the past nine years.

GENETIC EFFECTS

Bailey and Bagg,[1] as early as 1923, reported mutational effects on mice from roentgen exposure. These first appeared in the great grandchildren. Other workers failed to confirm this work. They felt that the controls were inadequate and that the mutations could have been spontaneous.

In 1927, Muller[5,6] reported that he was able to produce mutations in fruit flies by roentgen irradiation. Their life cycle is only ten days from egg to mature reproducing fly. They are available in almost limitless quantities. As a result, his work could be extensively done and quickly performed. He found that the mutational variations were haphazard and of the same type as occurred naturally. They were in the main harmful or lethal. Flies would occur without wings or with deformed antennae, for example. The mutations were roughly proportional to the roentgen-ray dosage applied. The natural mutational rate could be doubled with the use of 30 to 40 r. It was only natural for Muller to suspect cosmic rays as the cause of mutations under ordinary conditions. Biological effects are similar with roentgen rays, gamma rays, and neutrons. Cosmic rays are high speed, extremely penetrating rays, that reach us from outer space. They should have similar biologic potentiality. What is even more Muller was able to show that the roentgen irradiation effects in fruit flies were cumulative from generation to generation, and roughly proportional to the total applied energy. This is indeed something with which to reckon. Are we in the process of applying to the genes of each generation, roentgen effects which are cumulative and harming the human race?

Hanson, Heys and Stanton[3] in 1931 subjected male fruit flies to exposure to roentgen rays, all conditions being constant except that the voltage was varied. The mutational rates were judged by a particular lethal effect which occurred in their controls and against which comparison could be made. At 76 kv., 1,500 r was delivered to the male flies giving an increase which was about 70 times the control rate. Since the mutational rate is supposedly roughly proportional to the energy applied then 5 r (as used for a roentgen examination for pregnancy) would produce in the fruit fly over 1,500 multiplied by 70 as the increase in rate. This gives an increase of less than one-fourth the controls. This would be negligible even in fruit flies.

When chromosomes are struck by roentgen radiation, cosmic rays, and for that matter neutrons, a local injury to the genes can occur. The thread-like chromosome seems to be broken at that spot, and it often happens that the ends rejoin or attach themselves to other broken chromosomes. In this manner, there may be an actual local destruction of genes and also what is known as a translocation of a series of genes.

By way of review, let us outline some of the outstanding experimental evidence:

1. Roentgen rays or gamma rays in a hit or miss fashion on striking genes produce changes which are inheritable.

2. The changes in fruit flies are roughly proportional to the applied energy, the more energy applied, the more changes.

3. The effects are cumulative, that is, if given amounts of radiation are applied to successive generations of fruit flies a summation effect is produced.

4. The mutational effects may not become visible for several generations, until there is superimposition of gene defects from the male and female chromosomes.

5. In fruit flies the mutational rate is doubled with the use of 30 to 40 r of roentgen radiation.

Henshaw,[4] in 1941, gave a full review of this subject.

COSMIC RADIATION

If roentgen-ray effects are cumulative on

the genes, then it seems that the cosmic rays should also act in the same way. By the following calculation we have estimated that the genes should receive 0.05 r per year:

(1) One roentgen = 2.1×10^9 ionization pairs.
(2) Cosmic rays produce about 200 counts per minute, of pairs on the Geiger-Müller apparatus.
(3) Cosmic counts per day = $200 \times 60 \times 24$.
(4) Cosmic roentgens per day = $\frac{200 \times 60 \times 24}{2.1 \times 10^9} = 1.37 \times 10^{-4}$.
(5) Cosmic roentgens per year = $1.37 \times 10^{-4} \times 365 = 0.05$ r.

These figures have been checked by Miss Lillian Jacobson and Mr. Carl Braestrup, radiation physicists. Thus in a million years man would have received 50,000 cosmic roentgens to the genes. If the effects are cumulative from generation to generation this should have destroyed life. We therefore must assume that there is recovery from the effects of cosmic and therefore from smaller doses of roentgen radiation on the genes, since we know that 10,000 to 12,000 r are lethal for most living cells.

It is also important to realize that by the time the male and female human reproduce, between them they have supposedly accumulated about 3 r (0.5 r × 25 yr.) of cosmic rays on their genes. This is comparable to the amounts used for a pregnancy roentgen examination. We therefore feel that we are safe in saying that diagnostic roentgen exposures used at this time are producing no more harmful effects on the genes of the human race than cosmic rays, assuming cumulative effect.

It is generally true that rapidly growing cells are more sensitive to roentgen radiation. It is therefore interesting to compare the amount of cosmic roentgens received in the life cycle of the fruit fly and of man with 10 r of roentgen exposure, the amount which was used to prove that cumulation occurs on the genes of the fruit fly.

(1) Cosmic roentgens delivered daily to the earth = 1.37×10^{-4} r.
(2) The life cycle of the fruit fly is 10 days, equal to receipt of 1.37×10^{-3} r of cosmic energy.
(3) The ratio of a 10 r roentgen dose to cosmic-ray dose for 10 days = $\frac{10 \text{ r}}{1.37 \times 10^{-3}} = 7{,}299$. This is approximately 7,300 times as much roentgen radiation as cosmic energy received in the fruit fly life cycle.
(4) Assuming that humans' average age is 25 years at reproduction, they receive 0.05×25 of cosmic roentgens during this period, or 1.25 r.
(5) The ratio of the same 10 r of roentgen radiation to the cosmic rays for 25 years for the human is $\frac{10}{1.25}$ or 8 times as great, which is much less of a ratio than with fruit flies.

Living substance adjusts itself to its environment. It is therefore likely that the human genes are adjusted to receive without harm much larger doses of cosmic energy than the fruit fly.

Since the great majority of roentgen-ray induced mutations are harmful, it is likely that other forces than the cosmic rays have been the cause of beneficial mutations. Perhaps the diploid, triploid, and tetraploid effect on the chromosomes produced by chemicals such as colchicine, where larger plants are developed, is an example of beneficial mutation. Foods and minerals may have an important bearing, judging by some recent experimental work.

VITAMIN B COMPLEX AND MUTATIONS

Muller was not able to reverse the mutational effects produced by roentgen radiation. However, Gordon and Sang,[2] working at Aberdeen University, did succeed in preventing such changes by feeding the fruit flies niacin, giving additional evidence that the effects of irradiation on the genes can be reversed. Although this work has not been confirmed, it has received high praise from the Science Committee of the British Council. Niacin belongs to the vitamin B complex group that

participate in the formation of enzymic systems that are involved in the production of energy in living tissue. Warkany and Nelson,[8] by means of a vitamin B deficiency diet, have produced at will malformation of litters of rats. By feeding the mother rats a diet rich in liver and yeast the litters were born without the malformation.

Some organisms produce an excess of vitamin B complex in the intestinal tract which may be useful to the host. Where there is lack of such growth the person may have a vitamin B deficiency. This together with a defective heredity, injury or infection, may induce wild growth of cells or malignancy.

SUMMARY

1. Bailey and Bagg in 1923 reported that they had produced mutational effects in mice with roentgen irradiation.

2. Muller in 1927 showed that mutations could be induced in fruit flies by roentgen irradiation.

3. This was roughly proportional to applied dosage and cumulative from generation to generation.

4. Thirty to forty roentgens approximately doubled the control mutational rate in fruit flies.

5. Muller suggested that natural mutations might be the result of cosmic radiation.

6. By mathematical calculation, we have found that 0.05 r of cosmic rays reach the earth's surface annually. In one million years this totals 50,000 r.

7. Therefore if radiation effect is cumulative on the genes from generation to generation life should have been destroyed long ago.

8. Therefore, we are forced to conclude that there must be a recovery of the genes from radiation effects.

9. Gordon and Sang have prevented with niacin fruit fly mutations induced with roentgen radiation. This is practical proof that the genes can recover from such injury.

10. Warkany and Nelson have produced malformation in rats by means of vitamin B deficiency.

11. It is suggested that natural beneficial mutations probably have a different cause than radiation, as for example, the triploid effect produced by colchicine.

12. A diagnostic roentgen-ray exposure compares favorably with the amount of cosmic energy the body receives in a lifetime. Since it has been shown that recovery from such small doses occurs, then we can safely say that such degrees of exposure will not harm the coming generations of men.

941 Park Avenue
New York 28, N. Y.

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EDITORIALS

THE MEDICAL USE OF RADIOACTIVE IODINE

THE first radioactive iodine isotope was produced in 1935 by Fermi and his co-workers[1] who bombarded iodine with slow neutrons. This isotope had a half-life of twenty-five minutes and was later definitely identified as I^{128}. In 1938 Tope and Cork[2] after irradiating iodine with fast neutrons discovered a second isotope having a half-life of thirteen days. This isotope was identified as I^{126}. In the same year Livingood and Seaborg[3] described three additional isotopes, I^{124}, I^{129} or ^{131} and I^{130}, having a half-life of four days, eight days and 12.6 hours respectively. These investigators studied various reactions involved in the production of radioactive iodine isotopes by bombarding, in the Berkeley cyclotron, iodine, tellurium and antimony with 8 mev. deuterons, 16 mev. helium ions and neutrons. Shortly thereafter Abelson[4] isolated an isotope with a half-life of 2.5 hours which was a product of the fission of the uranium nucleus by neutrons. In a further analysis Abelson showed that the isotopes with half-lives of fifty-four minutes, twelve hours and eight days are also formed during the disintegration of uranium. They all are descended from active tellurium. Dobson and Fowler[5] conducted investigations along similar lines on uranium and thorium. They found still another isotope of 6.6 hour half-life, for which no tellurium parent could be demonstrated. It was thought that this was a direct fission product of the uranium or perhaps the descendant of a very short lived tellurium.

In view of the great complexity of the disintegration especially in the heavier atoms it is often very difficult to determine the exact radioactive nature of the decay products and their proportional amounts. Livingood and Seaborg[3] determined that the cyclotron-produced iodine isotopes emit beta rays of an energy of 1.2 to 2.1 mev. and gamma rays of an energy of 0.4 to 0.6 mev. with the single exception of I^{124} which yields positrons. By far the greater part of the radioactivity is due to the beta rays, the gamma-ray emission being very weak.

The most common method of producing radioactive iodine for medical purposes at present is to bombard in the cyclotron metallic tellurium with deuterons.* In this procedure the most important products are I^{130} of 12.6 hour half-life and I^{131} of eight day half-life. By varying the length of bombardment their ratio can be changed within certain limits. After a short bombardment the radioactivity due to I^{130} is about ten times that of I^{131}; then this ratio decreases with prolongation of the time of the bombardment. The other isotopes are formed in comparatively small amounts. For long range tracer studies the eight day I^{131} is used permitting observation over a period of several weeks or months, whereas for internal therapy the 12.6 hour I^{130} is preferred. After a bombardment of from three to ten hours the tellurium is removed from the target and the radioactive iodine separated by a chemical process. The final solution consists of distilled water and the radioactive iodine isotopes. Sufficient inert iodine in the form of sodium iodide is added to bring the total iodine content to a certain concentration. This solution is calibrated in millicuries and administered to the subject by mouth. In case of therapy the administration is made within one to four hours after the conclusion of the bombardment to prevent too much decay of the 12.6 hour iodine.

In the initial biologic investigations under-

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* The U. S. Government has just released the iodine isotopes produced in the fission of uranium.

taken by Hertz, Roberts and Evans[6] the only radioactive isotope available was I^{128} of twenty-five minutes half-life. This proved a great disadvantage since extensive tracer studies had to be conducted first and the period of observation was limited to about forty minutes. With the discovery of the isotopes of longer life the progress became more rapid. In 1941, Hertz[7] was able to give a report on a series of cooperative experiments which were carried out on various phases of thyroid function in relation to the radioactive iodine. Already the earlier experiments with the twenty-six minute I^{128} isotope demonstrated that the thyroid gland collects iodine at an extremely rapid rate, as a rule within ten minutes following intravenous injection, and that previous iodization decreases this collection. It is of particular importance that both the normal and hyperplastic thyroid take up a larger portion of a small dose than of a large dose of iodine. The later experiments with the isotopes of longer life and by making use of the multiple labelling showed that in Graves' disease the collection from a second dose of iodine is almost invariably less than from the first dose, and that the best measure of the amount of collection is the size of the thyroid, a fact which has great bearing in determining the dose to be administered. Still later experiments with an externally placed Geiger counter revealed that in non-iodized Graves' disease the initial iodine collection of the thyroid gland approximates 100 per cent for small doses (0.2 to 5.0 mg.) while in the normal, in previously iodized Graves' disease, and in large doses it is considerably smaller.

The selective accumulation of the radioactive iodine in the thyroid gland was also studied by Hamilton and Soley.[8] They chose patients with normal thyroid, hyperthyroidism, non-toxic goiter and hypothyroidism and measured the radioactivity by placing the Geiger counter directly against the isthmus of the thyroid. In order to obtain long range observations the eight day I^{131} isotope was used and the readings repeated at varying intervals for a period of from five days to four weeks. As in the experiments of Hertz and his co-workers, a marked avidity for the iodine was noted in hyperthyroidism and non-toxic goiter whereas in the normal and especially in hypothyroidism the collection of iodine was less. An interesting observation was that in hyperthyroidism the quantity of iodine dropped to from one-half to four-fifths of the original value within a few hours after it was taken up, indicating that the mechanism of iodine metabolism is also altered. In a further series of experiments, Hamilton and Soley determined the distribution of the radioactive iodine within the removed thyroid gland by means of auto-radiography. After suitable preparation microscopic sections of the thyroid tissue were placed on ordinary no screen roentgen films and held in close contact with a small press. Following the necessary exposure the sections were stained and studied under the microscope. In the normal thyroid gland there was a uniform distribution of the radioactive iodine throughout the section. In the hyperplastic thyroid tissue the colloid contained a much higher proportion of the accumulated radioactive iodine than the cells of the adjacent acini, suggesting that part of the iodine moves rapidly into the colloid while the remainder is discharged into the blood stream. In non-toxic goiter the radioactive iodine was stored predominantly in the cells and small acini which surround the larger acini. The authors also studied in this manner four cases of carcinoma of the thyroid. Surprisingly, there was a complete failure of the cancerous tissue to accumulate significant quantities of the radioactive iodine in all cases.

Impressive experiments were carried out on other phases of the thyroid gland and its metabolism by a number of investigators. The formation of thyroxine and di-iodothyrosine by the thyroid gland, the serial recording of the embryologic development of thyroid gland, the time of appearance of the ability to accumulate iodine by the fetal thyroid tissue in various animals, are a few of the problems studied.

Three salient facts have emerged from the extensive biologic studies which are important from the point of view of the therapeutic use of the radioactive iodine: (1) the thyroid tissue possesses a very marked selective avidity for the iodine which in proportion to the size of the

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gland is from twenty to two hundred times as high as that of any other tissue in the body; (2) this avidity is greater in diffuse hyperplasia of the thyroid tissue, in case there was no previous iodization and when the iodine is given in a small dose so as not to overflood the bloodstream, and (3) the administration of radioactive isotopes of short half-lives permits in view of the massive beta irradiation a selective destruction of the active tissue of thyroid gland.

Based on these facts several authors tried the treatment of various thyroid disorders by means of radioactive iodine. Recently, Hertz and Roberts[9] published the results in 29 cases of hyperthyroidism treated between March, 1941, and April, 1943, at the Massachusetts General Hospital. Considering that from three to five years have now elapsed since the time of treatment in all cases, this report permits a very good estimation of the value of the method over a longer period of time.

Hertz and Roberts employed a mixture of radioactive iodine isotopes, obtained by deuteron bombardment of tellurium, which was administered orally. Over 90 per cent of the activity was due to the I^{130} of 12.6 hour half-life and most of the remainder to the I^{131} of eight day half-life. The dose varied between 0.7 and 28 millicuries, depending on the clinical evaluation of the weight of the gland. In 19 cases one single dose was given and in the other 10 the treatment was repeated from two to four times at irregular intervals. No preliminary iodization was carried out in any of the cases and the total amount of radioactive iodine was kept below 2 mg. One day to several weeks later the administration of 5 mimins of saturated inert potassium iodide twice a day was started and continued for a period of from two to four months until an essentially normal basal metabolic rate had been maintained for at least several weeks. In 20 cases a complete cure was obtained, in 1 case the dose was subminimal, in 3 there was failure and in 5 subtotal thyroidectomy was performed subsequently. It is interesting that in all these latter cases the thyroidectomy was followed by hypometabolism and myxedema.

To obtain some comparison with the roentgen irradiation as practiced routinely in hyperthyroidism, Hertz and Roberts also expressed the dose of the radioactive iodine given in roentgens. Although admittedly such calculations are subject to an error of ± 50 per cent it was determined that a net collection of 3 millicuries of I^{130} of 12.6 hour half-life in a 30 gm. thyroid gives 1,000 r in decaying to zero, the initial rate being 55 r per hour. For I^{131} of eight day half-life the initial rate is only 3.6 r per hour and the decay so much slower that its therapeutic effectiveness is open to question. On the basis of this comparison it was possible to gradually raise the dose of the radioactive iodine administered. In 1941 it averaged 5 millicuries, in 1942 10 millicuries and in 1943 14.5 millicuries, the largest single dose being 21 millicuries.

In a second report from the same institution, Chapman and Evans[10] published an additional series of 22 cases of hyperthyroidism which were treated from May, 1943, to March, 1945. In these cases radioactive iodine alone was used without subsequent iodization or any other form of therapy. The preparation of the radioactive iodine and the method of administration were the same as used by Hertz and Roberts. The average dose, however, was considerably increased, until it amounted to from 40 to 50 millicuries. This represented 0.8 millicurie per estimated gram of thyroid tissue. Fourteen patients received a single dose, 3 were given two doses and 5 were given three doses. All responded well to the treatment, but 2 still have mild hyperthyroidism and 4 developed myxedema. In these latter patients a dose of 1 millicurie per estimated gram of thyroid tissue was given which apparently is too high. Reactions resembling roentgen sickness were observed in 6 patients without leaving any ill effects.

There has been a question from the earliest days of radioactive iodine investigations as to whether or not cancerous thyroid tissue possesses a similar iodine storing capacity. Unfortunately, the number of publications in this respect is rather small. Hamilton[8] studied 4 cases of carcinoma of the thyroid by removing the glands two days after the administration of the radioactive iodine and determining the distribution of the accumulated labelled iodine chemically and with the aid of auto-radiographs. There was no deposition of the radioactive iodine within the malignant areas of the thyroid gland in any of the cases in contrast to the normal tissue. Hamilton, therefore, drew the

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conclusion that this agent has no value in the therapy of the carcinoma of the thyroid. Later Frantz and her co-workers[11] reported the results of similar investigations in 3 cases of carcinoma of the thyroid with bone metastases. In 2 cases of colloid-containing metastases, one of which was of the adenoma malignum type, there was no uptake of the radioactive iodine, but in the third case a focus in the shaft of the femur consistently showed appreciable uptake of the material, although there were numerous other nonfunctioning metastases and the patient never exhibited clinical hyperthyroidism. Very recently Leiter and his co-workers[12] presented 2 additional cases of adenocarcinoma of the thyroid with functioning metastases and clinical hyperthyroidism. In 1 patient there was a complete absence of functional thyroid tissue in the neck so that the hyperthyroidism was the result of the distant metastases. These authors expressed the opinion that the internal irradiation with radioactive iodine in large enough doses might have a beneficial effect in similar cases.

In summarizing, it may be said that radioactive iodine has already proved to be of great value in tracer studies of various phases of thyroid metabolism. It also appears from the data available so far that its employment may be envisaged in the near future for the treatment of selected cases of hyperthyroidism and perhaps some types of carcinoma of the thyroid. However, a word of caution must be sounded against too much zealousness and indiscriminate use. Although all the authors state that they have seen no untoward effects on the normal tissue of the body, the fact remains that the bulk of excretion of the radioactive iudine occurs through the very vital and rather radiosensitive renal structures at a rate of from 30 to 40 per cent during the first four days and somewhat slower thereafter. Under certain circumstances, this rate of urinary excretion may even be higher or protracted over a considerable period of time. The experiences gained in the early days of radiology with radon solutions attest to the fact that observations over a period of many years are necessary before it is known whether or not the effect of such intensive tissue irradiation can be considered entirely harmless. Another disturbing factor is the great difficulty of accurately determining the dose to be administered. Since the total amount of radioactive iodine needed depends not only on the precise estimation of the weight of the thyroid gland, a procedure which in itself requires considerable skill, but also on the proportion and degree of activity of the functioning thyroid tissue, a gross over-irradiation may easily occur in individual cases. The relatively large incidence of myxedema tends to support such a view. In the thyroidectomized cases, a complete replacement of the thyroid tissue by fibrosis without any sign of regeneration was found in the majority of instances. Obviously, further careful investigations and prolonged clinical observations with radioactive iodine are necessary.

T. Leucutia

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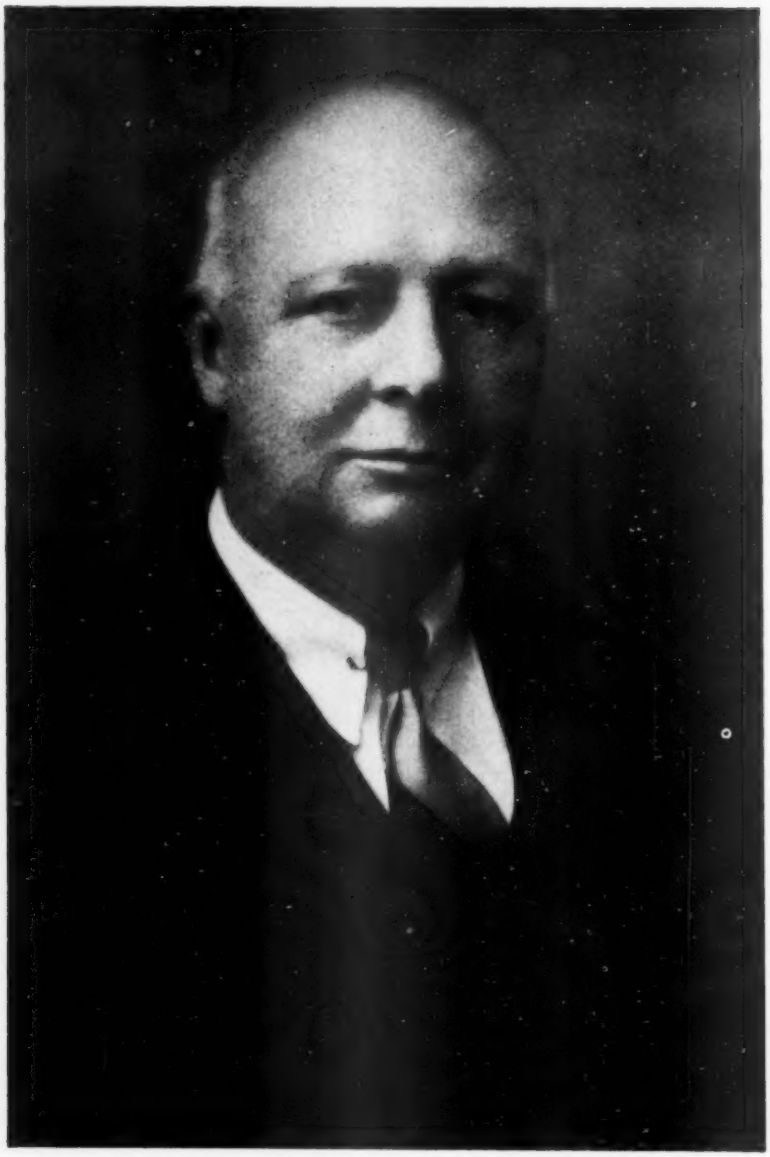

HARRY FULLER WAITE
1872-1946

DR. HARRY WAITE, one of the earliest of America's roentgen-ray pioneers, died on January 26, 1946, at his home in Hollywood, Florida. He is survived by his wife, Mrs. Laura Waite.

Dr. Waite was born in Bridgeport, Connecticut, on February 15, 1872. He was not quite twenty-four years old when Röntgen's discovery was announced. He immediately joined forces with his father, who founded the Waite and Bartlett Company in 1879 to manufacture roentgen-ray apparatus. He received the degree of M.D. from New York University in 1897, but

most of his active life was spent in invention, design, and manufacturing. On March 23, 1920, he was granted patent No. 1,334,936, on an oil-immersed shock-proof roentgen-ray unit with the tube and transformer in one container, which was the origin of the shock-proof dental unit, among other applications. Another basic patent contributing to shock proofing was No. 1,682,730, granted August 28, 1928, on the oil-immersed valve tube.

The Waite and Bartlett Company, some of whose static machines antedating the roentgen ray are still to be found in service in physiotherapy, was taken over in 1930 by the Picker X-ray Corporation, and Dr. Waite became the president of the Waite Manufacturing Division of that firm. Freed from business details, he applied himself to the more congenial task of designing improved apparatus, with particular reference to the three-phase principle. Early exposure to roentgen rays meanwhile had produced the late effects only too familiar to those who are cognizant of pioneer roentgen-ray history, and like so many others he underwent amputation of fingers, skin grafts on the hands, and also a malignant ulceration of the face. And like the other pioneers, he bore these ills with the courage that ever distinguished that group.

Dr. Waite was elected an honorary Fellow of the American College of Radiology on February 14, 1939.

Ramsay Spillman

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17–20, 1946.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Palace Hotel, San Francisco, Calif., June 29, 1946.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual meeting: San Francisco, Calif., July 1–5, 1946.

AMERICAN RADIUM SOCIETY
Secretary, Dr. E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo. Annual meeting: Assembly Hall, Health Center, San Francisco, Calif., June 28–29, 1946.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1–6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.
Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets annually second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

Ohio Radiological Society
Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiolcgical Society
Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, August 8, 9, 10, 1946, at Shirley Savoy Hotel, Denver, Colorado.

St. Louis Society of Radiolcgists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly on first Wednesday at dinner.

San Francisco Radiological Society
Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Shreveport Radiolcgical Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiolcgical Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiolcgical Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiolcgical Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiolcgical Society
Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

Washington State Radiolcgical Society
Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiolcgia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Faculty of Radiolcgists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiolcgical Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

Société Canadienne-Francaise d'Electrolcgie et de Radiologié Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Radiolcgical Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

South America

Sociedad Argentina de Radiolcgia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Peruana de Radiolcgia
Secretary, Dr. Victor Giannoni, Apartado, 2306 ,Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Sociedad Espanola de Radiolcgia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiolcgie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. Babaiantz, Geneva.
Secretary for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Rocky Mountain Radiological Society is resuming its Mid-summer Radiological Conference, which is to be held at the Shirley Savoy Hotel, Denver, Colorado, August 8–10, 1946. The committee is arranging an excellent program. The guest speakers will be Dr. John D. Camp, Rochester, Minnesota, Dr. William E. Costolow, Los Angeles, California, Dr. Ross Golden, New York, and Dr. H. Dabney Kerr, Iowa City, Iowa. All physicians interested in radiology are invited to attend this conference.

CANCER TEACHING DAY

A Cancer Teaching Day is to be held at Saranac Laboratory, Saranac Lake, New York, on Wednesday, June 19, 1946, under the auspices of the Medical Society of Franklin County, Saranac Lake Medical Society, Medical Society of the State of New York, and the New York State Department of Health, Division of Cancer Control. The meeting will be called to order at 3 P.M., with opening remarks by Morton L. Levin, M.D., Director, Division of Cancer Control. The following papers will be presented at the afternoon and evening meetings: Cancer of the Uterus and Vagina. By Arthur J. Wallingford, M.D., Albany Medical College, Albany, N. Y.; Cancer of the Breast. By Cushman D. Haagensen, M.D., Columbia University, New York; Cancer of the Stomach. By Robert J. Booher, M.D., Memorial Hospital, New York; Lung Tumors. By John D. Stewart, M.D., University of Buffalo School of Medicine, Buffalo, New York.

NEW ENGLAND ROENTGEN RAY SOCIETY

The New England Roentgen Ray Society held its last meeting of the season on Friday, May 17, 1946, at the Harvard Club, Boston. Officers elected for the coming year are Dr. Samuel A. Robins, *President;* Dr. Stanley A. Wilson, *Vice-President;* Dr. George Levene, *Secretary*.

The feature of the evening was the second George W. Holmes Annual Lecture which was delivered by Dr. Arthur C. Christie of Washington, D. C. Dr. Christie's subject was "The First Fifty Years of Radiology; The Elements Which Have Contributed to Its Growth as a Great Medical Specialty." Dr. Holmes and Dr. Christie were both presented with the Society's silver colonial pitcher which is emblematic of the occasion. Dr. Holmes received congratulatory telegrams from his former students from various parts of the country. The occasion was a fitting tribute to a great radiologist and teacher.

George Levene
Secretary

RADIOLOGICAL SOCIETY OF NEW JERSEY

At the time of the annual meeting of the Radiological Society of New Jersey held on May 22, 1946, the following officers were elected for the coming year: *President*, Dr. John Olpp, Englewood, N. J.; *Vice-President*, Dr. H. R. Brindle, Asbury Park, N. J.; *Secretary*, Dr. W. H. Seward, Orange, N. J.; *Treasurer*, Dr. R. Pomeranz, Newark, N. J.

UTAH STATE RADIOLOGICAL SOCIETY

The radiologists of the State of Utah met at a dinner meeting on May 15, 1946, and organized the Utah State Radiological Society. The following officers were elected for the ensuing year: *President*, Dr. James P. Kerby, Salt Lake City; *Secretary*, Dr. M. Lowry Allen, Salt Lake City. Meetings of the Society are to be held on the third Wednesday of the month during September, November, January, March and May.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

ROENTGENOGRAPHIC PATHOLOGY OF THE SKELETON. By J. Belot and F. Lepennetier. (With the collaboration of G. d'Allaines and L. Lamy.) Atlas III, Volume I. The Upper Extremity. Pp. 384, with many illustrations. Paris: Amedee Legrand and Jean Bertrand, 1944.

This is the first of three volumes of the third of a series of atlases of roentgenographic pathology of the skeleton, the two earlier atlases having been published several years before the war. In spite of the German occupation and in spite of the shortage of paper, of various other materials, and especially of skilled labor, this volume was published during the war. It deals with and illustrates non-traumatic diseases and tumors of the bones of the upper extremity.

The first section (sixty-nine pages) is devoted to lesions of the bones of the hand; the second section (forty-seven pages) deals with lesions of the bones of the wrist; the third section (thirty-eight pages), with lesions of the radius and ulna; the fourth section (forty-three pages), with lesions of the elbow joint; the fifth section (seventy pages), with lesions of the shaft of the humerus; the sixth section (thirty-four pages), with lesions of the shoulder joint; the seventh section (thirty-three pages), with lesions of the shoulder girdle (clavicle and scapula); and the eighth and last section (eight pages), with extensive lesions of an entire upper extremity, which could not well have been included in any of the other sections. The book is printed on excellent paper, and the roentgenograms are superbly reproduced. Smaller black, white and red diagrams appear alongside of each roentgenogram and help to clear up uncertain parts. Each roentgenogram is accompanied by textual explanations and pertinent comments.

Anyone who is acquainted with the authors and their work would know that they would not publish inferior work; they and the publishers deserve special credit for having succeeded in bringing out such an outstanding book despite the handicaps imposed by the war. A few conditions have not been adequately illustrated or have been omitted altogether; these include the syndrome characterized by multiple and asymmetrical fibrocystic disease, precocious puberty, multiple areas of abnormal pigmentation of the skin, with or without hyperthyroidism, cases of which have been reported by McCune, Albright, and others. Another condition which does not appear in this atlas is the general osteoarthropathy, sometimes known as pulmonary osteoarthropathy, or Marie's disease. No doubt the first of these omissions may be attributed to the war and to the impossibility of keeping abreast of the literature during its course. As for the second omission, this may have been intentional, the authors perhaps intending to deal with this condition in another volume.

If all the volumes in this series of atlases should be as good as this one—and there is every reason to think that they will be—every library should have them.

A. U. DESJARDINS

CANCER DE LA LARINGE. ESTUDIO RADIOLOGICA. By Felix E. Leborgne, M.D., Chief of the Radiological Service of the Pereyra Rossell Hospital, Montevideo, Uruguay. Pp. 387, with 355 illustrations. Montevideo, Uruguay: Casa A. Barreiro y Ramos, 1943.

After careful perusal of this monumental work one is impressed with a sense of great admiration for the author and gratitude that he has felt impelled thus to make a permanent record of his labors in this particular field of radiology. The publisher has made an exceptionally attractive volume which is substantially bound. The nearly four hundred pages of the book consist in large part of illustrations, which include ordinary roentgenograms of exceptional quality and tomograms which are perhaps as appropriate and helpful in the study of the larynx as in any part of the body. There are numerous drawings illustrative of laryngoscopic findings and explanatory line drawings to render more sure the interpretation of the roentgenograms. Numerous photographs of anatomical specimens and photomicrographs further assist in elucidation of this subject. The entire book is devoted to cancer of the larynx, as is indicated by the title. The text is arranged

in logical consideration of the anatomical and technical considerations of the study of the larynx and hypopharynx and a classification of pharyngeal and hypopharyngeal tumors, all of which have been discussed at great length so that the work presents as complete a study of laryngeal carcinoma and its differential diagnosis from the roentgenologic standpoint as one could possibly imagine. It is to be hoped that an English translation of this valuable treatise may become available.

James T. Case

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

THE USE OF TANNIC ACID IN BARIUM ENEMAS

By COLONEL JOHN B. HAMILTON
MEDICAL CORPS, ARMY OF THE UNITED STATES

IN A PERSONAL communication from Lieutenant Colonel George L. Sackett, M.C., A.U.S., I learned that when making barium studies of the colon better mucosal patterns on the evacuation films could be obtained if powdered tannic acid were added. The results of the addition of one level tablespoonful of powdered tannic acid to each 2 quart barium and water mixture, prior to the administration of the enema, have been so satisfactory that it is now routine at this Army general hospital to make this addition. In no case has any patient complained of any unpleasant after effects from the addition of tannic acid to the barium enema mixture. Unless contraindicated, castor oil or compound licorice powder in addition to tap water enemas is used in preparing the patient.

Various patterns obtained are shown in the accompanying illustrations.

210 North Central Ave.,
Glendale 3, California

Fig. 1. Evacuation pattern—Normal.

Fig. 2. Evacuation pattern—Ulcerative colitis, chronic, severe, cause undetermined. Changes can be seen throughout the mucosa, most marked in the cecum and ascending colon.

Fig. 3. Evacuation pattern—Ulcerative colitis, chronic, severe, cause undetermined. In addition to other mucosal changes, severe granular degeneration is demonstrated in one long segment of the colon

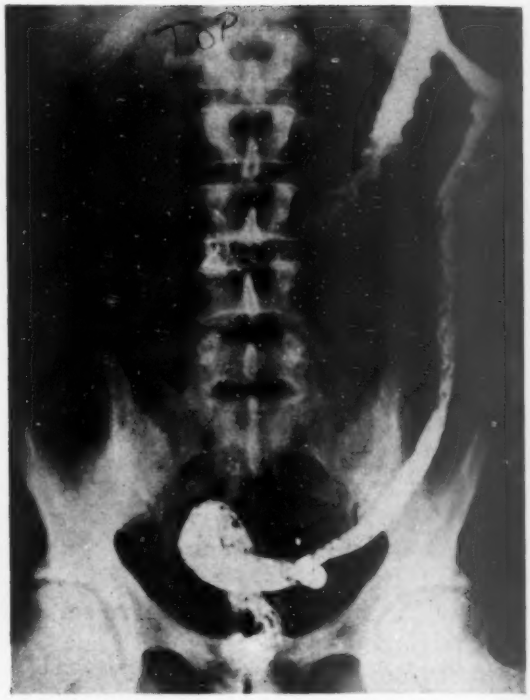

Fig. 4. Evacuation pattern—Ulcerative colitis, chronic, cause undetermined with pseudopolyposis. A Mikulicz colostomy of the transverse colon has been performed.

Fig. 5. Evacuation pattern—Congenital polyposis.

Fig. 6. Immediately following the administration of the enema—There was a constant filling defect in the proximal sigmoid colon, found at operation to be a polyp 2 cm. in diameter, and diagnosed colloid carcinoma without evidence of extension. Diverticula are also demonstrated.

Fig. 7. Same case as shown in Figure 6. Evacuation pattern—The diverticulosis is demonstrated; however, the carcinomatous polyp is not demonstrated.

Fig. 8. Same case as shown in Figures 6 and 7. Air contrast study—The polyp is well demonstrated.

THE LATERAL PROJECTION IN ROENTGENOGRAPHY OF THE STERNOCLAVICULAR ARTICULATION

By ROBERT KURZBAUER, B.Sc., R.T.
From the Department of Radiology, Mount Sinai Hospital
CLEVELAND, OHIO

THE roentgen examination of the sternoclavicular articulation and the projection of its shadow on the film with a minimum of distortion and confusion with the underlying structures have always confronted the roentgenologist with some difficulties.

The demonstration of this articulation is of great importance in many conditions of either traumatic or pathologic nature; thus the necessity of obtaining images of diagnostic value, even under adverse conditions has led to the development of many techniques designed to achieve this goal. Short distance exposures, off center, and oblique projections have been utilized to visualize this area in the posteroanterior aspect.[1,2,3,4,5]

The routine lateral projection,[2,3] due to the superimposition of both articulations

FIG. 1.

and resulting interpretative difficulty, has not been frequently employed.

A lateral projection whereby each articulation could be clearly defined would constitute not only a useful supplement to the routine posteroanterior views but prove sufficient in itself, especially in many cases where, because of trauma to the patients' anterior chest wall, a prone position would be painful and immobilization hard to maintain.

Clark[2] briefly mentions the possibility of such a method. A procedure has been evolved which, by adapting the principles of the well known technique for the lateral upper dorsal spine, modifies this view to produce satisfactory roentgenograms of each articulation separately and particularly detailed images of the sternal half of the clavicle.

The patient is positioned laterally recumbent, the affected side lowermost, on the roentgenographic table, with a frontal plane through the sternoclavicular articulations coinciding with the long axis of the Potter-Bucky diaphragm. The arm nearer the film is extended fully cephalad, the hand grasping the end of the table. The uppermost arm is pulled caudad along the lateral chest wall using slight force. This maneuver will rotate the upper half of the shoulder girdle caudad in relation to the one nearer the film, resulting in an adequate separation of the shadows of both articulations on the film.

The principal ray is directed caudad at an angle of 15 degrees from its perpendicular position through the lower articulation, using a 3 inch localizing cone (Fig. 1). The center of an 8 by 10 inch cassette is aligned to coincide with the principal ray. The patient is instructed to arrest breathing on maximum inspiration.

The foregoing procedure will yield an effective separation of the otherwise superimposed articulations and present an undistorted true lateral view. The projection of the lowermost articulation above rib level into the soft tissues of the neck clears the image from all confusing thoracic densities (Fig. 2 and 3).

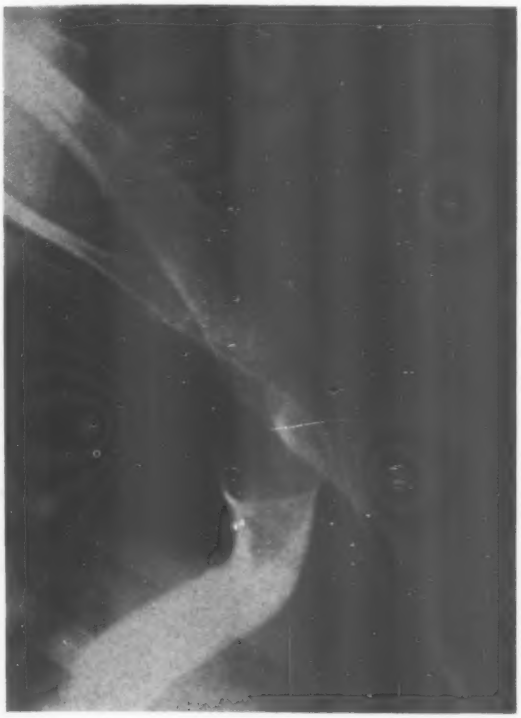

Fig. 2.

Fig. 3.

It is of interest to note that in this projection the trachea may be seen in its fullest extent which could be helpful in the recognition of any deviation of this structure from its normal course as seen from the lateral aspect.

Mount Sinai Hospital
Cleveland 6, Ohio

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIGNOSIS

HEAD

NEW, GORDON B., and FOSS, EDWARD L. Tumors of the nose and the throat. *Arch. Otolaryng.*, Aug., 1944, *40*, 142–149.

Bowen's "precancerous dermatosis" is still considered by some authors as a precancerous dyskeratotic process but is regarded by the majority as a highly specialized form of superficial squamous cell epithelioma with lateral intraepithelial spread. Two typical cases of Bowen's disease of the mucous membrane have been reported by Brighton and Altman. In one of these there was involvement of the anterior part of the nasal septum and in the other a vocal cord was involved. It is pointed out that histopathologically, Bowen's disease and epithelioma of the mucous membrane resembling Bowen's disease are closely related.

Blair and Byars recommend that any black melanin-containing mole be removed. They express the belief that any doubtful localized chronic change occurring on the vermilion or the mucocutaneous border of either lip should be regarded as squamous cell carcinoma until definitely proved not to be that. These workers do not excise lymph nodes of the neck routinely in all cases of cancer of the lip. They advise excision of these nodes in those cases in which it is felt that danger of metastases is present. This decision is made on the basis of the virulence of the new growth, from the degree of extension and from the history of meddlesome or irritative treatment.

In all cases of cancer of the tongue, cautery-biopsy is done by Blair and Byars, complete excision-biopsy when practical. This is usually followed by interstitial implantation of a large dose of radon. Excision of the lymph nodes of the neck should be considered in almost all cases of cancer of the tongue.

Martin and Koop believe that the most frequent and probably the most important form of chronic irritation from the standpoint of carcinogenesis in the oral mucous membranes is that due to avitaminosis B.

Tumors of the Nose and Accessory Sinuses. Dermoid cyst of the nose (Holmes) usually starts in connection with either the nasal bones or the frontal bones, so that even if the cyst presents itself at the tip of the nose, its stalk of origin will be found to extend to, and be in contact with, either the nasal bones or the frontal bone.

McGillicuddy believes that intranasal encephalomeningocele is probably diagnosed occasionally as nasal polyps or as fibroma. He suggests that in some cases in which meningitis and death have followed the removal of what seemed to be an innocent polyp the tumor may well have been an encephalomeningocele.

Davis presents a case of nasal fibroglial heterotopia. He concludes that tumors of this type belong to a group of congenital benign fibrogliomatous tumors which originate embryologically from encephaloceles.

Tumors of the Lips and Mouth. Johnston lists the cysts usually found in the floor of the mouth as dermoid, epidermoid, ranular, thyroglossal, mucous and branchial. Any cyst in this site, regardless of its origin, has to be removed surgically.

Two cases of generalized neurofibromatosis in which there was bulky invasion of the oral cavity are reported by Martin and Graves. Both patients were children and one of the oral tumors took on malignant, locally invasive characteristics and caused death.

Schreiner and Christy review 636 consecutive cases in which cancer of the lip was treated by irradiation. Of 27 patients who had lesions that were proved to be metastatic and were treated by implantation of radon seeds and radium needles and by irradiation with high voltage roentgen rays, only 2 (7.4 per cent) remained well five years or longer.

In the discussion of treatment of cancer of the mouth Scarborough states that irradiation is the method of choice in the treatment of the primary lesion. Excepted are pedunculated tumors occurring on the lip, buccal mucosa and anterior third of the tongue, as well as adenocarcinoma occurring on the roof of the mouth. These should be excised by cautery after preoperative irradiation.

Wilson states that the eradication of the primary lesion of carcinoma of the lip may be accomplished in most cases by either surgical means or irradiation. A block dissection of the regional lymph nodes increases the likelihood of a permanent cure.

Tumors of the Nasopharynx. Lenz has reviewed 63 cases of cancer of the nasopharynx and he concludes that, at present, roentgen therapy is the treatment of choice in these cases. Roentgen therapy at 200 kv. can control the cancer for five years or longer in about a fourth of all cases.

Eighty-five per cent of the nasopharyngeal tumors encountered in practice fall into the group of undifferentiated epithelioma, lymphoepithelioma, lymphosarcoma and plasmocytoma. Martin believes that irradiation is the treatment of choice in dealing with these tumors.

Tumors of the Oropharynx and Hypopharynx. The Schmincke tumor is defined as a malignant neoplasm of lymphoid tissue usually found in the pharyngeal region. This tumor is characterized by a peculiar admixture of lymphoid cell intimately associated with epithelial elements of an immature squamous or epidermoid type. There is a tendency to early and rapid metastasis. This tumor is, however, extremely radiosensitive.

Tumors of the Larynx. The anatomy of the anterior commissure tendon is discussed by Broyles. He concludes that in all probability early recurrence in cases of carcinoma of the anterior portion of the larynx should be considered continuation rather than recurrence and that carcinomatous growth was retained in the tendon or in its insertion into the thyroid cartilage.

Medical interest in histoplasmosis has been aroused recently by the increased number of reports published. A case is reported in which there was laryngeal histoplasmosis. The patient was a male, sixty-three years of age, a small polypoid tumor was seen on the left vocal cord, from which the diagnosis was made (microscopically). Another case of larygneal histoplasmosis is reported in which the larynx appeared white and nodular.

Laryngeal tuberculosis is always secondary to a pulmonary focus. Donnelly, in a review of 1,800 tuberculous patients found that in 26 cases laryngeal symptoms developed before any systemic signs.

Roentgen examination of a patient who has explained laryngeal symptoms may disclose early chondroma. Chondroma may exist undetected for years in the subglottic region of the larynx. (The most useful information which can be obtained by roentgenologic examination of the larynx is obtained by a laminagram.)

Iglauer presents a case of myoblastoma of the larynx. (Eight such cases have already been reported.) On mirror examination a large pedunculated tumor was seen in the posterior portion of the larynx between the arytenoid cartilages.

LaJeune and Bayon point out that the ideal case of laryngeal carcinoma, from an operative standpoint, is one in which the lesion involves the middle portion of a vocal cord with both ends uninvolved.

Tumors of the Trachea. A case of tracheal ectasia occurring in a white adult male is reported. (Synonyms include tracheal hernia, tracheocele, tracheal diverticulum, aerial goiter, aerocele and bronchocele.)

Tumors of the Esophagus. Twenty-five cases of grossly pedunculated benign tumors of the esophagus are reviewed.

Carcinoma of the esophagus is a highly malignant disease. The tumor remains localized until very late and metastasis to distant organs is found in less than 40 per cent of the cases. Watson finds that carcinoma of the upper part of the esophagus is curable by irradiation. Smither, Clarkson, and Strong believe that roentgen therapy has much to recommend it in the treatment of carcinoma of the esophagus for it is the most effective method of securing palliation and at the same time causes the patient least discomfort.—*Mary Frances Vastine.*

Fletcher, Russell, Sarcoid of the nose. *Arch. Otolaryng.*, June, 1944, *39*, 470–473.

Sarcoid is so similar to tuberculosis in so many of its manifestations that many authorities believe that they are the same disease, although it has sufficient variations from typical tuberculosis to cause other authorities to disagree. Boeck, in 1899, was the first to use the term "sarcoid." Typically, Boeck's sarcoid included involvement of the skin, the mucous membranes and the lymph nodes. Gradually new regions were found involved and given the name of the observer, such as Jungling's disease, involving the bones, or Mikulicz' syndrome, involving the lacrimal and salivary glands.

Histopathology of Sarcoid. The unit of the

microscopic picture is the epithelioid tubercle without caseation. It consists of large pale-staining polygonal epithelioid cells forming a mass about the size of a miliary tubercle.

Differential from Tuberculosis. (1) The tubercles in sarcoid remain stable and unchanged for long periods of time and do not usually tend to break down, ulcerate or caseate. (2) Multiple lesions in various parts of the body are commonly found in sarcoid. However, none of the 4 patients having sarcoid of the nose reported in this paper had lesions in parts of the body other than the chest. (3) Most persons with sarcoid have negative reactions to tuberculin.

Treatment of Sarcoid. No treatment has been found to be effective. In 2 of the cases reported by the author, the nasal lesion was excised surgically and did not recur.

Conclusion. Four cases of nasal sarcoid are reported. The diagnosis in each case was proved biopsy. Undoubtedly, many such cases are overlooked.—*Mary Frances Vastine.*

Schugt, Henry P. Pain referred to the face, neck, upper extremity and chest due to lesions in the ear; report of two cases. *Arch. Otolaryng.*, May, 1944, *39*, 430–431.

Pain due to pathologic conditions in the ear simultaneously involving such large areas as the face, the neck, the arm and the chest is an uncommon occurrence. The 2 patients described in this article were treated for chronic mastoiditis. The author gives an explanation of the neurologic pathways according to present knowledge: Afferent branches of the upper thoracic nerves extend along the carotid arteries and afferent fibers of vagus origin join the plexuses on the internal and external carotid arteries and reach the area of the trigeminal nerve. Afferent impulses therefore arising in primary lesions such as those in the mastoid area are conducted from the site of the lesion into the spinal cord through afferent components of the thoracic nerves, which traverse the nerves associated with the common internal and external carotid arteries. The autonomic components of referred pains localized in the lower cervical and upper thoracic segments and the upper extremity which are due to lesions in the mastoid area can thus be explained. Werne's experimental work showed that the referred pain associated with visceral lesions has its origin in changes in the skin and the underlying tissues through viscerocutaneous reflexes; in other words, the sensation of pain is the direct result of afferent impulses which arise in the periphery.—*Mary Frances Vastine.*

Gough, C. W. C. Tomography of the temporomandibular joint and ramus of the mandible. *Brit. J. Radiol.*, July, 1944, *17*, 213–215.

In standard views of the temporomandibular joint there is usually distortion of the neck and ramus of the mandible. An undistorted view is absolutely essential to plastic repair and such views can be obtained by tomography. The technique is simple and it does not take any longer time than the standard views. The patient's head is placed in the true lateral position and a section at a depth of 1 inch is satisfactory. Good results can be obtained with a homemade tomograph attachment, an exposure of 65 kv., 30 ma. and $3\frac{1}{2}$ seconds exposure time (four-valve unit) at a distance of 40 inches using a Potter-Bucky diaphragm.

Tomography is also useful in some other conditions to demonstrate lesions that are not clearly shown by routine roentgenography. Among these are congenital facial asymmetry, fibrous and bony ankylosis of the temporomandibular joints, external fixation of a fractured mandible and gunshot wounds of the mandible. Illustrative cases are described and illustrated with tomograms.—*Audrey G. Morgan.*

Ross, John A. Some observations on dental changes in possible riboflavin deficiency. *Brit. J. Radiol.*, Aug., 1944, *17*, 247.

Some cases of dental deficiency in a group of young men from a native camp in the Middle East are reported. They showed loose incisor teeth but without any gum infection, which is unusual. Roentgenograms of two typical cases are given. Except for osteoporosis at the margin of the alveoli the rest of the bone showed good density and none of the other bones were affected. The author thinks it possible that this condition may be caused by a deficiency of riboflavin in the diet. The blood calcium of the patients was slightly low.—*Audrey G. Morgan.*

NECK AND CHEST

Weldman, William H., and Keiffer, Jean. Control, duplication and standardization of radiographic chest technique. *Am. Rev. Tuberc.*, March, 1944, *49*, 203–226.

While variations equivalent to 5 kilovolts on

either side of the density generally considered optimum do not affect the value of a chest roentgenogram considered singly, film pairs more than 4 kv. equivalent apart are not satisfactory. Frequently such films lead to disagreement among various interpreters concerning the progress of a pulmonary lesion or conclusions are reached which are not substantiated by the patient's clinical course.

A review of serial roentgenograms in an average laboratory demonstrated variations equivalent to 5 kv. or more at least 50 per cent of the time; moreover, variations equivalent to 4 kv. in stereoscopic pairs were common.

Prior to the inauguration of accurate technique control 35 per cent of the authors' serial films were within a ±2 kv. (peak) comparison tolerance. In order to study the underlying factors producing this technique discrepancy, a thin, copper step tablet surrounded by a lead mask was constructed. This small device could be mounted directly on a cassette, and variations in tablet image densities produced on different roentgenograms by a supposedly similar technique could be compared—density differences on two films taken by the same technique thus indicating total technique variations. In addition, a set of standards consisting of tablet images taken at 2 kv. intervals and covering the entire range of routine techniques was prepared. Comparison of a tablet's image on a selected roentgenogram with the standard permitted estimation to within 1 kv. of the kv. (peak) which should have been used to obtain the desired results if all other factors of exposure, material, and processing remain constant. Review of a year's work (7,000 films) following institution of rigid total technique control measures based on routine utilization of the copper step tablet showed 93 per cent of their roentgenograms within limits of ±2 kv. (peak) from expected results.

Included in the paper is a description of the step tablet, an account of its practical uses and a helpful analysis of common processing variables and errors—the key to great improvement in serial film technique duplication.—*John R. Hannan.*

Cole, Warren H. Classification of chronic cystic mastitis. Editorial. *Surg., Gynec. & Obst.*, July, 1944, *79*, 109–112.

Practically all writers agree that cancer may and does develop in areas of chronic cystic mastitis even though there is as yet no means of determining just how often and in what types of chronic cystic mastitis this may occur. A study of numerous specimens of chronic cystic mastitis reveals five or six major histopathologic features.

1. Fibrosis is encountered in practically all specimens.

2. Hyperplasia of the glandular elements is the next most common change observed. This hyperplasia may affect the glands themselves or the ducts.

3. Not infrequently the hyperplasia develops with changes which are of a precancerous nature, i.e., there is much variation in size and shape of the cells.

4. There may be a variable degree of dilatation of the ducts or glands, particularly the former.

5. Sometimes these cyst-like spaces may attain a size several centimeters in diameter (when they are designated as cysts).

6. Lymphocytic infiltration is noted to a variable degree but no significance can be ascribed to this change.

When the pathologic changes above described are correlated with the clinical findings, the following four distinct classifications may be identified:

1. Adenofibrosis. In this lesion the predominant change is fibrosis. Glandular elements are present in decreased numbers. Grossly the breast is firm but resilient; the glandular elements are so sparse that the cut surface is fairly homogeneous and presents an ivory white surface. Tenderness and pain are slight. Adenofibrosis was encountered in 22 per cent of the author's cases. The average age was 37.4 years.

2. Benign parenchymatous hyperplasia. The predominant microscopic feature of this lesion is a proliferation of the ducts, glands and connective tissue stroma, particularly the ducts. Palpation of the breast reveals numerous nodules, varying from 5 to 15 mm. in diameter. On cut section the larger ones contain material which may vary in color and consistency from thin amber colored fluid to thick, yellow brown, pasty material. In the series, 46 per cent of the cases were classified in this group. The average age of the patients was 43.7 years.

3. Precancerous hyperplasia. The hyperplasia in this group resembles that seen in cancer. Even though cellular activity is pronounced, nowhere is there evidence of invasion or of the breaking through of normal barriers.

Palpation of these breasts will reveal no characteristics different from those described under benign parenchymatous hyperplasia. Of the entire series 22 per cent of the cases were classified in this group; the average age was 41.6 years.

4. Cystic disease. In this type of lesion the cystic spaces may attain a size equal to 4 to 6 cm. in diameter; they may occur singly but are usually multiple. In this group are classified the blue-domed cysts of Bloodgood. The cysts are usually palpated as firm, smooth tumors but occasionally are mildly fluctuant. Ten per cent of the series were classified in this group; the average age was 46.6 years.

Conclusions.

1. Since adenofibrosis and cystic disease rarely develop into cancer, operation need not be advised in these lesions unless symptoms are significant.

2. Since it is impossible to distinguish benign parenchymatous hyperplasia from precancerous hyperplasia clinically, and since either may become malignant, excision will be advisable in these lesions.—*Mary Frances Vastine.*

Crawford, J. H. Tomographic appearance of the azygos lobe, with a description of two cases and a report of seven cases. *Brit. J. Radiol.*, Oct., 1944, *17*, 319–322.

The anatomy and embryology of the azygos lobe are described. Tomography is important in detecting it and descriptions of 2 cases in young men are given and illustrated with tomograms. There is a thin curved line convex outwards over the right upper field, usually ending in a dense comma-shaped or pea-shaped shadow at about the level of the second costal cartilage. The line represents the azygos fissure and the terminal opacity the azygos vein seen end-on. The image resembles that of a spermatozoon or tadpole lying mostly below the clavicle.

At Preston Hall where the author works 7 cases of this anomaly were found among 6,000 cases examined, or in 0.11 per cent. Heredity is thought to play a part in its causation. Underwood and Tattersall made roentgen examinations of 10 relatives of 2 of their patients and the anomaly was found in 1 relative in each case. They conclude from this that heredity does play a part in its causation. In 5 of the author's cases half of the relatives were examined and no examples found, but as only half the relatives were examined the negative evidence is not conclusive.—*Audrey G. Morgan.*

Ferguson, George B. Hemangioma of the adult and of the infant larynx. *Arch. Otolaryng.*, Sept., 1944, *40*, 189–195.

The first report of a case of hemangioma of the larynx was made by Mackenzie in 1864. To date, 123 cases of hemangioma of the larynx have been recorded in the available literature. The author reports 2 additional cases. Two distinct classes have been described: (1) the adult and (2) the infantile.

Classification. The infantile type of hemangioma of the larynx is the rarer. It is located below the vocal cords. The more common type, occurring in adults, is located on or above the vocal cords.

Etiologic Factors. Over 90 per cent of the patients have been adults, and two-thirds have been males. In some cases the condition has undoubtedly been congenital and was made manifest shortly after birth. A few observers have suggested as possible etiologic factors severe cough traumatizing the vocal cords, faulty or excessive use of the voice and acute infections.

Pathologic Types. Two main types have been described—the cavernous and the simple. The tumor is designated as cavernous angioma when its vascular channels are widely dilated and the connective tissue septa thin; it is called simple angioma when composed of many small blood vessels.

Diagnosis. Quite different sets of symptoms characterize the infantile and the adult form of hemangioma:

1. Because of the subglottic position of the infantile form, a slight infection of the upper respiratory tract is often sufficient to cause symptoms of respiratory distress. Wheezing and labored respiration, quite similar to what is seen in streptococcic laryngitis, are present. However, the signs of acute infection are not so prominent.

Direct laryngoscopic examination of a young infant with severe dyspnea may be difficult, and a subglottic tumor lying diffusely under the mucous membrane may not be seen readily. Probably no attempt should be made to obtain a biopsy in such cases because of the danger of hemorrhage. The absence of inflammatory swelling and of a diphtheritic membrane is a valuable negative sign.

Lateral roentgenograms of the larynx may show a discrete tumor in the subglottic larynx.

2. In cases of the adult type of hemangioma the symptoms are often vague and of extremely

long duration. Hoarseness, followed by cough, dyspnea, hemoptysis and dysphagia are the most common complaints.

The tumor as seen through a laryngeal mirror is usually described as resembling a raspberry, irregular in surface and purplish in color. The tumor has been seen to spring from a vocal cord, a ventricular band, an arytenoepiglottic fold, an arytenoid and the epiglottis. The diagnostic importance of the "phonation sign of Monzel" has been stressed. This consists of increased firmness, erection, diminution in size and deepening of hue of the tumor during phonation.—*Mary Frances Vastine.*

Goorwitch, Joseph. Mass chest roentgenography and admissions to Olive View Sanatorium. *Am. Rev. Tuberc.*, Sept., 1944, *50*, 214–222.

The consensus of those experienced in diseases of the chest is that only by roentgenography can minimal and at times even more advanced pulmonary tuberculosis be diagnosed. Thus a chest examination is inadequate and incomplete unless it includes a roentgenographic study. Furthermore, wider use of chest roentgenography, both in survey and in all hospital admissions, would result in the uncovering of more minimal tuberculosis and would improve remarkably tuberculosis control.

The effect of preinduction and isolated preemployment chest roentgenographic examinations in Los Angeles County on admissions to Olive View Sanatorium has been to produce an absolute and relative increase in the number of males admitted, thereby reversing the prewar predominance of females. The immediate five year prewar ratio of females to males, 1.26, was actually reversed to 0.85 in the period from January 1, 1942 to April, 1943. Despite this increase there was no change in the incidence of far advanced disease among the entire male group admitted. This does not indicate a diagnostic failure attributable to routine chest roentgenography, but demonstrates that few with minimal disease, more with moderately advanced and a high percentage with far advanced disease enter a sanatorium.—*John R. Hannan.*

Mora, J. M., Isaacs, H. J., Spencer, S. H., and Edidin, L. Posterior mediastinal goiter. *Surg., Gynec. & Obst.*, Sept., 1944, *79*, 314–317.

Partially intrathoracic goiters occur relatively often, especially in areas of endemic goiter. Their incidence is placed at about 12 to 20 per cent. Completely intrathoracic goiters are much rarer. The rarest of the intrathoracic goiters is the type found in the posterior mediastinum. Only 6 such cases have been previously reported.

The intrathoracic thyroid masses are practically always of the adenomatous type. Lahey and the Criles have repeatedly stated that they have never seen a diffuse goiter (exophthalmic goiter, primary hyperthyroidism) become truly intrathoracic.

The descent of these thyroid masses into the chest is facilitated by a number of factors. These include breathing, swallowing, muscular activity in flexing and rotating the head, nonresistance of the more pliant structures of the thoracic inlet, and gravity.

Clinically, the patients with this lesion fall into one of four groups: (1) those with no symptoms; (2) those exhibiting signs and symptoms of thyrotoxicosis; (3) those exhibiting pressure symptoms; (4) those with the combination of pressure symptoms and toxicity.

In the Cleveland Clinic series, hyperthyroidism was present in 50 per cent of all patients operated upon for intrathoracic goiter. Cough, dysphagia, changes in the quality of the voice and hoarseness are rare. The esophagus and recurrent laryngeal nerves are rarely involved. One should suspect a malignant lesion if there is any involvement of the recurrent nerves.

In the case reported, the roentgenogram disclosed a large globular mass occupying the right upper thoracic cavity; on lateral views this mass was seen to lie in the posterior mediastinum. The diagnosis at this time was thyrotoxicosis and the mass was believed to be a large intrathoracic goiter, although the roentgenologist felt that the diagnosis of a neuroblastoma could not be definitely excluded.—*Mary Frances Vastine.*

Blades, Brian, and Dugan, David J. Tuberculoma of the posterior mediastinum. *Am. Rev. Tuberc.*, July, 1944, *50*, 41–47.

The varied clinical nature of tuberculosis makes it necessary to include the disease in the differential consideration of a chronic obscure lesion in almost any part of the body. There is no doubt that, until quite recently, many patients with bronchiectasis, bronchogenic carcinoma, as well as other chronic pulmonary diseases have been institutionalized and spend

their remaining days in tuberculosis sanatoria. Until surgical treatment of pulmonary disease became feasible, differentiation between far advanced pulmonary tuberculosis and bronchogenic carcinoma or bronchiectasis was chiefly of academic interest. Now, if accumulated data suggest that a lesion is a tumor, every effort is expended to establish the diagnosis—even to the use of diagnostic thoracotomy. If one waits for truly diagnostic signs and symptoms, the tumor is generally inoperable. Moreover, the risk of open thoracotomy is trivial compared to the dangers of untreated thoracic tumors.

It is inevitable, however, as more thoracotomies are performed to identify masses of unknown etiology that a few inflammatory lesions will be mistaken for tumors and excised. In fact, preoperative diagnostic errors have led to excisions of calcified laminated abscesses, tuberculomata, etc., in the past. Nevertheless, the underlying principle of early removal of a tumor mass when ordinary diagnostic methods fail to reveal the true nature of the lesion is still sound. Moreover, many of these inflammatory masses would, in all likelihood, cause trouble later.

While it is not so difficult to distinguish inflammatory from neoplastic disease in the mediastinum as it is in the lungs, considerable opportunity exists for confusing tuberculous nodes with lymphatic tumors. Operative intervention is seldom advocated in this group; thus the question of surgical excision seldom arises. Rarely, tuberculosis produces a lesion in the posterior mediastinum the nature of which is not suspected despite careful study by every facility available.

The authors report such a case. A large posterior mediastinal tumor was discovered and preoperatively diagnosed as a primary nerve tumor. It was surgically excised, and to the complete surprise of all the physicians who had examined the case, the pathologist reported the finding of tuberculosis.

Evidence suggests, and follow-up of the authors' case seems to substantiate this, that extirpation of a well encapsulated tuberculous lesion will not cause dissemination of the disease.—*John R. Hannan.*

Auerbach, Oscar. Perforation of tuberculous lymph nodes into the trachea and bronchi. *Arch. Otolaryng.*, June, 1944, *39*, 527–532.

In the course of routine autopsies on 1,656 tuberculous patients, the author has observed perforations into the trachea and the bronchi, 22 (1.3 per cent) times.

Age. The youngest person was one and one-half years of age; the oldest, fifty-seven years. The fact that the majority of patients (12) were more than twenty-one years of age is in contrast to the distribution given in the majority of reports, namely, that the perforations occur chiefly in children.

Race. Sixteen of the 22 patients were Negroes.

Number and Site of Perforations. In 13 of 22 cases a single rupture occurred, and in 9 instances, two or more perforations were present. The perforations occurred mainly in the region of the carina. The multiple perforations took place not only in multiple areas of the air passages but also into the gastrointestinal tract, particularly into the esophagus.

Pathologic Appearance. In 7 cases, a calcified lymph node perforated the lumen of the air passages. Although the rupture of calcified nodes is seen more frequently in adults, it occurs also in children.

The development of emphysema in the mediastinum, extending into the neck from the rupture of a tuberculous lymph node into the air passage was first described by Benda in 1902.

Microscopically the inner wall of the perforation, as well as the inner wall of the liquefied lymph node, is lined by a zone of caseation or by a pyogenic membrane.

Clinical Observations. In none of these cases was there a dramatic, rapid course ending in death due to suffocation. These clinical findings are in contrast to those in the vast majority of reports in the literature.

Fifteen of the 22 cases showed a progressive caseous process of the lymphatic system. Roentgenograms of the chests of most of these persons revealed a widening of the mediastinum due to an enlargement of the tracheobronchial lymph nodes. In only 2 of the 15 cases was there a cavity present in the lungs before the rupture of the lymph node.

There were two events which often followed the perforation. One of these was the sudden appearance of tubercle bacilli in the sputum or gastric contents; the other was a bronchogenic dissemination from the aspiration of the caseous contents into the pulmonary parenchyma.

Healing. The author's findings cause him to doubt that the softened caseous material can be completely expectorated with subsequent complete healing.

Summary and Conclusions. (1) Adhesion of

the lymph node to adjacent structures is an important bar to the development of tuberculous mediastinitis. (2) The systemic disease in the cases studied was usually found to be a fulminating lymphohematogenous tuberculosis in which cure of the general infection and necessarily, therefore, of the local tracheobronchial complication was unlikely. An infrequent but important exception occurred in the cases in which a calcified particle, in itself the end stage of a healing process, was the source of the perforation. In these cases the normal respiratory mobility of the bronchial tree was probably of chief importance in the rupture of the lymph node.—*Mary Frances Vastine.*

Nathanson, L., Frenkel, D., and Jacobi, M. Diagnosis of lipoid pneumonia by aspiration biopsy. *Arch. Int. Med.*, Nov., 1934, *72*, 627–634.

Ten patients who had a history of receiving liquid petrolatum for many years and who had suggestive roentgenograms pointing toward the diagnosis of lipoid pneumonia were investigated by means of aspiration biopsies. The material aspirated from the lungs of 5 of the 10 patients gave smears containing the characteristic lipoid macrophages.

The histologic response of the lungs to liquid petrolatum is said to be as follows. The droplets of oil entering the alveolar space act as a chemical and mechanical irritant. Soon monocytic cells appear and phagocytose the oil droplets. At first these cells take on a foamy appearance; later in the course of imbibition they resemble ordinary fat cells. At first round or oval, they become bulky and of irregular contour, depending on the number of oil droplets phagocytosed. The latter press the nucleus toward the periphery but retain their subdivision for a long time, possibly until the cells disintegrate. In this stage one finds giant cells and fibrosis. As time goes on the fibrosis increases and the oil of the disintegrated lipophages becomes entrapped in the meshwork of the fibrous tissue. If the amount of fat is considerable and if fibrosis and giant cell formation are so abundant as to form a tumor one speaks of a paraffinoma. The latter stage was not encountered in this series of cases.

Roentgenographically the pulmonary lesion was not characteristic, but the infiltration, as a rule, involved the lower lobes of both lungs and particularly the lower lobe of the right lung. The mesial portion of the latter lobe adjacent to the heart was the earliest site of involvement. The infiltration then spread to the dependent portions of the lobe above the diaphragm. The process varied in character from patchy infiltration to dense consolidation with fibrosis. There was little change in the lesion over prolonged periods.—*J. J. McCort.*

Pirkle, H. B., and Davin, Julia R. Loeffler's syndrome; transient pulmonary infiltrations with blood eosinophilia. *Am. Rev. Tuberc.*, July, 1944, *50*, 48–51.

In 1931 Loeffler described a transient pulmonary infiltration associated with a high blood eosinophilia. The syndrome consists of asthma with a cough, eosinophilia ranging from 10 to 60 per cent, low grade fever accompanied by mild leukocytosis and an elevated blood sedimentation rate. Despite the relative absence of chest signs, the roentgen features are striking. They consist of pulmonary infiltrations—usually in the lower lung fields. The infiltrates disappear rapidly and do not cavitate. Subsequent observers have stressed, frequently, that the infiltration is based on an underlying allergy.

A case report follows. The authors' patient differed from many other cases reported in that she had no asthma, and the fleeting pulmonary infiltrations continued to migrate a rather long time, eight months, before the lung fields demonstrated complete clearing by roentgenographic examination.—*John R. Hannan.*

Yoskalka, J. S. Atypical pneumonia simulating pulmonary tuberculosis. *Am. Rev. Tuberc.*, May, 1944, *49*, 408–413.

For many years it has been the teaching of the medical profession to view a patient, subacutely ill, with roentgenologic evidence of infiltrations in the upper lung fields, as probably tuberculous until proved otherwise. According to Slack, bronchiectasis, asthma, pulmonary carcinoma, pneumoconiosis, cardiac hypertrophy and pulmonary abscess are the nontuberculous lesions most frequently misdiagnosed as pulmonary tuberculosis.

Reports of the past several years indicate that atypical pneumonia not infrequently can produce lesions indistinguishable from pulmonary tuberculosis on the roentgenogram—particularly when the upper lung fields are involved. Approximately 7 to 10 per cent of cases with atypical pneumonia have upper lobe in-

volvement. Seven such cases were among the author's 96 cases of atypical pneumonia. Two of these 7 cases are reviewed briefly, and 1 case of pulmonary tuberculosis originally diagnosed as atypical pneumonia is presented.

The author concludes that any patient with an apical lesion failing to demonstrate clearance on roentgenographic examination within twenty days from the initial study should be suspected of pulmonary tuberculosis. Furthermore, sputum studies are indicated in all doubtful cases. If lesions persist for twenty days from the onset of symptoms, and routine sputum studies are negative for the tubercle bacillus, sputum and gastric concentrates, as well as guinea pig inoculations, are indicated. Because of the apparent increase in atypical pneumonia, early differential diagnosis is mandatory.—*John R. Hannan.*

NEEDLES, ROBERT J., and GILBERT, PHILIP D. Primary atypical pneumonia; report of 125 cases, with autopsy observations in one fatal case. *Arch. Int. Med.*, Feb., 1944, *73*, 113–122.

This paper is a study of atypical pneumonia with analyses based on 125 cases. There was 1 fatality in the group and the autopsy observations are presented in detail.

The earliest appearance of changes detectable in the roentgenograms of the chest in these cases is on the second or third day. The symptoms are usually in advance of the initial roentgen changes just as in the later stages of the disease the roentgen changes are far in advance of changes in the clinical appearance of the patient. In several cases in which examinations were made in the first twenty-four hours of the illness no demonstrable changes were noted and the serial films thereafter demonstrated the gradual development of the pulmonary involvement. The authors found that the first changes take the form of a faint and usually localized exaggeration of the peribronchial markings, so that they have a streaked or linear appearance. The hilar markings are usually prominent and the changes may be projected into the pulmonary field from one or both hilar regions. There seems to be no preference for one lung over the other but the disease more commonly affects the lower pulmonary field. The mild attacks are usually unilateral and the more severe ones are generally bilateral. The earliest changes do not ordinarily extend beyond the middle of the lung and may cling closely to the lower mediastinal border. The subsequent changes are extensions of the early picture. The markings increase in prominence and the area exhibits a mottled homogeneous increase in density.

Clear cut shadows such as are present with lobar pneumonia are seldom seen. Pleural thickening or evidence of pleural exudate is rare, having occurred in but 1 case in this series. In the more severely ill patients, those having marked dyspnea, cyanosis and large amounts of sputum, roentgen examination revealed a diffuse, mottled infiltration resembling miliary tuberculosis. In 1 case in the series it was difficult to distinguish the lesion from that of a primary tuberculosis complex. The author states that in many cases there is little to choose in the roentgen picture between primary atypical pneumonia and various of the fungus infections or pneumoconiosis.—*J. J. McCort.*

GRIER, GEORGE S., III. Importance of bronchography in cases of unresolved pneumonia. *Arch. Int. Med.*, June, 1944, *73*, 444–448.

This is a statistical study of 40 patients with bronchiectasis. In this series of 40 patients 9 were referred to the clinic for persons with diseases of the chest because of a history of chronic cough, hemoptysis, or recurrent colds in the chest, while the remaining were admitted to the hospital with an initial diagnosis of primary atypical pneumonia.

Roentgenograms demonstrated stringy and mottled densities in the lower lobes of the lungs, usually unilateral and radiating out from the hilum toward the diaphragm. Lateral roentgenograms of the chest frequently revealed a pneumonic process behind the diaphragm or a cardiac shadow which could not be seen in the posteroanterior exposure.

Bronchographic studies were done in cases in which resolution failed to occur in four to six weeks and iodized poppy seed oil was injected into both sides even when the pneumonic process was unilateral. Studies with iodized oil are contraindicated in the period of acute pneumonitis since this procedure may produce an exacerbation of the acute process.

In summarizing the statistical data it is found that the distribution of bronchiectasis was usually unilateral (30 cases) and most frequently involved the lower lobe of the left lung (20 cases, or 50 per cent). The most frequent type of dilatations demonstrated were tubular and fusiform with 19 and 15 cases respectively. Only 6 cases of the saccular form are noted.

The author concludes that bronchographic study should be done in all cases of pneumonia which fail to resolve in a reasonable period, which is about four to six weeks.—*J. J. McCort.*

Shields, D. O. Tuberculous pneumonia. *Am. Rev. Tuberc.*, Aug., 1944, *50*, 122–130.

In its essence this report represents an analysis of treatment methods in 52 patients with tuberculous pneumonia. Generally, three major treatment plans are open for consideration: (1) immediate pneumothorax; (2) delayed pneumothorax: (3) bed rest until caseated areas have liquefied and then pneumothorax or thoracoplasty to close cavities and control infection.

From his studies the author, realizing the fallacy inherent in statistics on a small series, concludes:

1. Immediate pneumothorax appears to produce the better results when compared with bed rest in cases of partial consolidation with moderately high fever and moderately severe toxemia.

2. Some cases demonstrating roentgenologic homogeneous consolidation will respond slowly to pneumothorax.

3. Generally, in extensive, complete consolidation collapse is not effective and pneumothorax will not influence the disease progress.

4. Patients showing partial consolidation with a low grade fever and mild symptoms may be observed during strict bed rest and followed by institution of a pneumothorax if extension occurs or symptoms increase.

5. Early pneumothorax in tuberculous pneumonia does not increase the percentage of empyemata.

6. Adhesions appear to be slightly less extensive if pneumothorax is induced early.

7. Empyema develops more frequently when extensive adhesions are present.

8. Re-activation of tuberculous pneumonia, both while pneumothorax is being given and following lung re-expansion, occurs in a high percentage of cases.

9. Thoracoplasty probably should follow pneumothorax if collapse is inadequate due to adhesions or in the event that caseation is extensive. In selected tuberculous pneumonia cases thoracoplasty, even as a primary measure, may be tolerated better than reports indicate.—*John R. Hannan.*

Thornton, T. F., Jr., Adams, W. E., and Bloch, R. G. Solitary circumscribed tumors of the lung. *Surg., Gynec. & Obst.*, April, 1944, *78*, 364–370.

There is a group of primary lung tumors that arise in smaller peripheral bronchi. They give rise to a rather indefinite group of symptoms, have a characteristic roentgen picture and are quite easily confused with solitary metastatic tumors and infections in the lung. These solitary circumscribed lung tumors constitute about 25 per cent of all primary lung tumors. Included in this discussion are 23 patients seen at the University of Chicago Clinics in the past ten years with a solitary rounded lesion that was at least 2 inches in diameter in the lung. The authors have included only patients in whom microscopic proof of the diagnosis was obtained or in whom certain clinical features made the diagnosis fairly certain.

One table in the article lists the diagnoses in this group of patients. Seventeen of the 23 rounded opacities demonstrated on roentgen examination were malignant lung tumors. Only 3 were metastatic; 14 were primary in the lung. One patient had a benign lung tumor. Such a tabulation emphasizes three important points:

1. So-called cannon-ball tumors of the lung, if seen as solitary lesions, are most likely primary in the lung.

2. Metastatic tumors to the lung are usually multiple when demonstrated clinically.

3. Highly differentiated neoplasms are relatively common among the primary lung tumors.

Certain other interesting points brought out in this article include:

1. The most common error made in this series was in the diagnosis of tuberculosis. Two patients were operated on for a solitary circumscribed lesion which was later found to be a tuberculoma; in 2 other patients the clinical diagnosis of tuberculoma was made because of calcium deposits in the lesion.

2. The clinical history and physical examination were of less aid in this series of patients than is usually the case in diseases of the chest.

3. Roentgenoscopic and roentgenographic examinations demonstrated every tumor in the series and gave some clues as to the type of the lesion. Calcification within the lesions indicated tuberculosis. (It is noteworthy that in not one of the 4 cases of tuberculosis were tubercle bacilli demonstrated in the sputum.)

4. Bronchoscopy was done in 12 patients but in only 2 was a positive biopsy obtained.

5. The almost complete failure of the usual aids to make an accurate diagnosis in these cases suggests very strongly the use of early exploratory thoracotomy as a diagnostic procedure.

Differential Diagnosis.

1. Metastatic tumors. Actually, the only way to make the diagnosis is to find the primary lesion.

2. Tuberculosis. In some cases, there will be other evidence of infection with acid-fast bacilli in the lung fields. Calcification is never seen in a malignant tumor although it may be present in benign lung tumors. If a cavity is demonstrated and no tubercle bacilli are found a neoplasm must be strongly suspected.

3. Chronic lung abscesses, in the absence of a definite history, can be diagnosed only by biopsy at thoracotomy.

4. Mediastinal lesions offer the greatest problems in differential diagnosis.

5. Substernal thyroid.

6. Lymphomas.

7. Aneurysms.

8. Bronchogenic and gastric cysts.

9. Low grade mediastinal abscesses, neurofibromas, chest wall tumors, and so forth.—*Mary Frances Vastine.*

REISNER, DAVID. Boeck's sarcoid and systemic sarcoidosis (Besnier-Boeck-Schaumann disease); a study of thirty-five cases. Part I. Clinical observations. *Am. Rev. Tuberc.*, April, 1944, *49*, 289–307; May, 1944, *49*, 437–462.

Because so many diverse sources have furnished observations from which the composite picture of sarcoidosis has developed, its nomenclature has become unwieldy. Several of the terms used in describing this disease are: multiple benign sarcoid, benign miliary lupoid, lupus pernio, benign lymphogranulomatosis, non-caseating tuberculosis, Besnier-Boeck's disease, Schaumann's disease. In the first two sections of this paper are presented the clinical observations in a study of 35 cases of sarcoidosis. The majority of the patients were Negroes—tending to confirm the observation that in the United States the disease occurs with greater frequency in Negroes than in white persons.

While sarcoidosis is essentially a widespread disseminated disease, the classical picture, including characteristic cutaneous and osseous lesions associated with involvement of the lymphatic system, is present in the minority of patients. More frequently, the lesions seem limited to the visceral organs and are associated with a generalized lymphadenopathy. The most common findings are those of pulmonary involvement in combination with systemic lymphadenopathy. The marked variations in clinical manifestations are due, in part, to the protracted course, the tendency to spontaneous regression and the occurrence of new phases.

In this group of 35 patients there were 17 demonstrating lymphadenopathy in combination with pulmonary involvement. In the remaining 18 patients there were more or less widespread systemic manifestations associated with lymphatic pulmonary involvement.

While the roentgenologic changes in the lungs are extremely variable in extent and distribution, the following descriptions are representative of the principal types: (1) discrete, diffusely disseminated, small, nodular foci which may be identical with those observed in acute miliary tuberculosis. The foci may be evenly distributed throughout both lungs or more pronounced in the midportions; (2) diffuse or localized, linear or strand-like interstitial ("peribronchial-perivascular") densities; (3) patchy, coalescent densities, usually in combination with widespread linear and discrete nodular shadows. In addition to these changes, definite roentgen evidence of mediastinal and tracheobronchial lymph node enlargement was demonstrable in 30 of the 35 cases.

Cutaneous sarcoid occurred in 40 per cent of the series. Three main forms were observed: the discrete nodular, the large nodular, and the diffuse infiltrating, plaque-like variety. A combination of these forms was seen occasionally.

Roentgen evidence of bone involvement was observed in one-fourth of the group. The typical lesion is the "so-called" osteitis tuberculosa multiplex cystoides of Jüngling. Occasionally other forms are seen, i.e. (1) circumscribed—consisting of punched out, ray-transparent areas of bone destruction, usually medullary; (2) diffuse—reticulated, lace-like pattern of bone destruction with expansion and thinning of the cortex. Although the osseous changes are most common in the phalanges of the hand and feet, other bones may be involved occasionally. Extension into the joints is uncommon; moreover, bone and skin lesions frequently occur concomitantly.

Rarely, the heart may be involved by direct invasion, but the more common cardiac manifestation is right heart failure secondary to extensive pulmonary changes.

Sixty per cent of the group reacted negatively to the intracutaneous Mantoux test using up to 1 milligram of old tuberculin, and about one-fourth of the group demonstrated serum protein levels above 7 grams per cent.

Regression of the lesions, even to the point of complete disappearance of objective manifestations, was the outstanding feature in 9 cases. In 5 patients, the lesions became stationary, and in 9 others, the disease was progressive leading to death in 7 instances. Five of these 7 demonstrated evidence of tuberculosis at autopsy, thus indicating a possible relationship between these two morbid conditions.

In differential diagnosis, Hodgkin's disease and disseminated hematogenous tuberculosis deserve particular consideration.

There is no effective treatment for sarcoidosis available at present, but a variety of therapeutic agents have been used empirically with some success.—*John R. Hannan.*

Sellors, T. Holmes, Blair, L. G., and Houghton, L. E. Diagnosis and treatment of lung abscess; symposium. *Brit. J. Radiol.*, June, 1944, *17*, 165–176.

The three participants in this symposium are the surgeon, roentgenologist and physician at the Thoracic Unit at Harefield. Sellors pointed out that the one of the many forms of lung abscess that interests the surgeon is solitary putrid abscess of the lung. The microscopic infectious material is generally aspirated from dirty tooth sockets or the nasopharynx. It enters a small terminal air tube and blocks it and atelectasis, infection, breaking down of tissue and suppuration ensue. It is frequently believed that abscesses occur chiefly at the base, but as a matter of fact the commonest sites are the posterior part of the upper lobe and the apex of the lower lobe. An outline and diagram of the course of the sublobar bronchi which explain this localization are given.

The mortality in treatment of lung abscess is 25 to 40 per cent. This can be improved only by early drainage. It is customary to delay six to eight weeks for conservative or postural treatment. The surgeon should be allowed to see all cases as soon as they are recognized and join in the decision as to treatment.

Roentgen diagnosis can generally be made if the clinical picture is considered in connection with it. Localization is of primary importance and lateral roentgenograms are absolutely necessary for this purpose. The radiologist and surgeon should screen the patient together to determine the exact site of the abscess. If there is fluid over the suspected area the aspirating needle should not be used. Once the abscess is located the patient should be placed in such a position that it is dependent. If two-stage drainage is practiced a metallic marker should be placed in the bed of the resected rib among the packing used to promote adhesions. In this way the accuracy of the approach can be checked by anteroposterior and lateral views before the second operation. Control of healing which cannot be visualized directly can be helped by filling the cavity loosely with gauze soaked in radiopaque oil. If a fistula persists the whole problem should be re-examined in order to exclude the possibility of malignancy, tuberculosis or congenital lesion.

Blair defined four groups of lung abscess: the acute pyogenic abscess, suppurative chronic pneumonia, pyemic abscesses, frequently multiple, and chronic lung abscess. The pyogenic lung abscess usually shows a cavity containing a fluid level, situated peripherally with surrounding reaction or consolidation. The conditions to be differentiated from this form of lung abscess may be extrapulmonary or intrapulmonary. The commonest extrapleural conditions are pleural effusion and diaphragmatic hernia. The intrapulmonary conditions are lung cysts, due to infection in congenital abnormalities and disintegration of lung tissue due to cancer or tuberculosis or occasionally syphilis or actinomycosis. Roentgenograms are given illustrating these differential diagnoses.

Pyemic abscesses are often multiple and may occur anywhere in the lung. Each resembles an ordinary pyogenic abscess except that there is not so much surrounding reaction. Chronic lung abscesses may exist for many years without showing roentgen signs. They are not merely acute abscesses that have been present for a long time but they are abscesses that have partially healed and in the process have become epithelialized. There are many cavities communicating with the bronchial tree by numerous fistulae, sometimes giving the roentgen appearance of an ordinary localized bronchiectasis such as is often seen after the healing of an area involved in suppuration of the lung. It is usual to differentiate between putrid and non-

putrid abscesses of the lung but if the sputum is not offensive it should suggest to the roentgenologist that the condition is one of those mentioned above and not a pyogenic lung abscess.

Houghton discussed the medical aspects of abscess of the lung and concluded that nonsurgical cases of lung abscess should be treated along the same lines as the general sanatorium treatment of tuberculosis, that is by a carefully regulated life under open-air conditions designed to increase general fitness and resistance. It is hoped that penicillin may prove useful in abscess of the lung when it becomes available for that purpose.—*Audrey G. Morgan.*

Hodson, C. J. Four primarily radiological lesions found in traumatic chest cases. *Brit. J. Radiol.*, Oct., 1944, *17*, 296–299.

Descriptions of four types of traumatic chest lesions are given which were found frequently in a series of 250 thoracic casualties; so far as the author knows they have never been described before.

The first is solid missile tracks. A missile may pass through lung tissue and leave no roentgen evidence but in 12 of the cases there were radiopaque linear shadows along the path of the missile. When viewed at right angles they appear as definite bands along the track of the missile but when seen end-on or obliquely they appear as small oval or rounded shadows. They may lead to the discovery of foreign bodies otherwise invisible behind the heart shadow or beneath an effusion.

Other missile tracks are not solid but contain air. They differ from the solid tracks only in the fact that there is a bronchus somewhere along their course which drains the blood away and air takes its place. They must be differentiated from tuberculous lesions.

Extrapleural hematomata are found in rib fractures and in cases of foreign body in or just inside the ribs. These extrapleural collections of blood may become infected, and if they do they can be drained without involving the pleural cavity and the danger of empyema be avoided.

Contusion of the lung may occur after nonpenetrating injuries of the chest wall. It causes an early clouded appearance which for the few days before it clears may resemble an inflammatory condition or a pleural effusion. It may obscure lung detail for the first four or five days after an injury and may cause hemoptysis. Illustrative roentgenograms are given.—*Audrey G. Morgan.*

Bobrowitz, I. D. Mediastinal herniation in artificial pneumothorax. *Am. Rev. Tuberc.*, Aug., 1944, *50*, 150–159.

The mediastinum contains two weak areas, sites of mediastinal hernia predilection—the one anterior and the other posterior. Herniation, bulging or ballooning of the mediastinal parietal pleura across the midline occurs most commonly in the anterior mediastinum behind the sternum between the second and fourth sternocostal articulations where the right and left mediastinal parietal pleura are in apposition. There, areolar tissue, a few lymph nodes and vessels and small vascular twigs offer little resistance to herniation. Less frequently, posterior mediastinal herniation takes place between the dorsal spine and aorta behind and the heart and esophagus in front. Occasionally with extreme degrees of herniation, serious complications, even death, ensue.

The unusual and interesting features of the single case reported are:

1. In a patient with a left artificial pneumothorax, a mediastinal herniation extended across the midline into the right chest, reaching to the dome of the right diaphragm and into the right apex.

2. When, to the left artificial pneumothorax, a right artificial pneumothorax was added, bilaterality of the mediastinal hernia became evident. Its size and appearance varied with phases of respiration.

3. A diagnostic problem arose in attempting to differentiate an apparent right spontaneous pneumothorax from a left mediastinal herniation. The diagnosis was established as a left mediastinal herniation by noting an entirely different shape to the right lung's apex after right artificial pneumothorax was established; and, second, by the installation of saline into the pneumothorax space. Roentgenograms and fluoroscopic observation in the decubitus position demonstrated the saline at the right apex, thus indicating that the fluid was free to flow from the left hemithorax to the right through the herniation space.—*John R. Hannan.*

Goldman, Alfred, and Roth, Harold. Spontaneous pneumothorax: a report of three unusual cases. *Ann. Int. Med.*, Dec., 1944, *21*, 1011–1021.

Three case studies are presented and discussed. All three developed spontaneous pneumothorax and each exhibited an unusual complication. The first case is that of a fifty-one year old male with previously unrecognized cystic disease of the lungs. The removal of a large amount of air and the injection of the patient's own blood into the pleural cavity resulted in a rapid clinical cure. It was thought that this case presented congenital cystic lesions because no definite etiological factor could be found in the history which would indicate that the cysts were acquired. In this patient the pneumothorax was first deflated and then 15 cc. of the patient's own blood injected. Other substances which may be used are 30 to 67 per cent glucose, iodized oil, 0.5 per cent solution of silver nitrate, oil of turpentine, guaiacol in iodoform, iodized talc, and plain talc.

The second case was that of complete atelectasis of the upper lobe of the left lung, associated with a spontaneous pneumothorax. Pneumothorax had been present for eleven months. The collapsed lung rapidly re-expanded following bronchoscopy and there was evidence of disease in the lungs following re-expansion. A careful survey of the literature shows only one previous report of atelectasis following idiopathic spontaneous pneumothorax.

The third case was that of spontaneous hemopneumothorax with recovery followed by a recurrence of the pneumothorax. This is the third reported case of this condition. It has frequently been stated that adhesions follow hemothorax and prevent recurrence. This accounts for the rarity of the condition.—*J. J. McCort.*

Eisen, David. Right aortic arch with report of eight cases. *Radiology*, June, 1944, *42*, 570–578.

Right aortic arch is a congenital defect which has been considered very rare but with the development of roentgen examination it may prove more frequent than has generally been believed. Fluoroscopic examination is necessary for its demonstration and it may not be detected on the flat roentgenogram.

A review of the embryonic development of the aorta and sketches of the circulation in a four week embryo are given. Arkin believes that right aortic arch is essentially a double aorta, representing a throw-back to the reptilian type of heart.

Eight cases are discussed and illustrated with roentgenograms. They were found incidentally in fluoroscopic examination of the chest for other conditions. None of them had caused any symptoms. As there is a vascular ring completely surrounding the trachea and esophagus, there may be more or less serious signs of compression. If a stenosis develops in the left fourth branchial vessel early in embryonic life before the right fourth vessel has evolved into the subclavian artery, then the right fourth branchial arch will develop into the functioning aortic arch; in that case the left subclavian artery and diverticulum represent an aborted left aortic arch and the obliterated vessel which joins them indicates the area of stenosis.

The essential features in the roentgenogram are that the shadow of the ascending arch of the aorta is on the right side, compressing the esophagus and displacing it to the left; the transverse arch is high up, crossing over the right bronchus, which is on a higher level than the left. This is an important point in the diagnosis of this condition. The trachea and esophagus bulge forward over the transverse arch of the aorta which is situated behind them. The shadow of the aortic arch is absent from its normal position and the conus region is unusually clear because the descending part of the aortic arch is not superimposed on it.!

The roentgen demonstration of this anomaly is important not only because of the signs of compression which it may cause but because of the necessity of differentiating it from other and more serious abnormalities. The heart is not affected.—*Audrey G. Morgan.*

Holmes, H. R. A case of patent ductus arteriosus associated with multiple pulmonary aneurysms and infective endocarditis. *Brit. J. Radiol.*, Oct., 1944, *17*, 312–315.

Patent ductus arteriosus is now known to be a predisposing cause of subacute bacterial endocarditis; this disease, which is otherwise fatal, is sometimes cured by ligation of the duct. It is therefore important to make complete roentgen examination in cases of patent ductus arteriosus in order to determine the indications for operation.

A case is described and illustrated with roentgenograms. The author believes that roentgenograms of such a case have never before been published. The patient was a man twenty-six years of age who complained of lassitude and breathlessness on exertion with fortnightly

attacks of sharp pain below the sternum and right nipple. He was discharged after an illness lasting eleven months and returned a month later because two of his attacks of rigors and fever had been accompanied by hemoptysis. Roentgen and clinical examinations and the presence of a murmur in the left second and third interspaces with a systolic thrill led to a diagnosis of patent ductus arteriosus with infective endocarditis and pulmonary infarction. The patent ductus was ligated and the murmur stopped but two days later the patient died after a copious hemoptysis.—*Audrey G. Morgan.*

Johannsen, M. W., and Connor, Charles A. R. Cor pulmonale with bilateral aneurysms of the pulmonary artery, interventricular septal defect, patent ductus arteriosus and terminal Ayerza's syndrome. *Ann. Int. Med.*, Feb., 1943, *18*, 232–237.

Aneurysms of the pulmonary artery are said to be so rare as to constitute almost a curiosity. From 1905 to the present time there have been 28,180 autopsies in Bellevue Hospital and in only 1 previous case was this lesion found. The patient was a forty-four year old white woman with cyanosis of the entire body. She was dyspneic and orthopneic. She coughed frequently, raising blood-streaked sputum. The jugular veins were distended and filled from below. There was a loud harsh, systolic murmur heard both at the apex and the base. A short diastolic murmur was audible along the upper part of the left sternal border. The second pulmonic sound was accentuated. The blood pressure was 160/108. The liver was palpated about 5 cm. below the costal margin. A teleroentgenogram disclosed generalized cardiac enlargement, most marked along the right border and the outflow tract of the right ventricle. Dilatation and calcification of the right and left pulmonary artery were evident.

The patient died nine days after admission and at autopsy the heart was found to be markedly enlarged both to the right and left. The right ventricle was dilated and its muscle hypertrophied, measuring at its widest portion 1.5 cm. There was a defect in the interventricular septum, immediately below the auriculoventricular junction. The foramen ovale was closed. The aorta showed no evidence of syphilis. The aortic arch communicated with the pulmonary artery through a widely patent ductus arteriosus, which measured 1.2 cm. in diameter and 1 cm. in length. The pulmonary conus, pulmonary artery and its branches exhibited a moderate, and in places, a severe degree of atherosclerosis with calcification. The left pulmonary artery was dilated prior to its entrance into the lungs. Its wall was thin and the aneurysm was filled with a gray, laminated clot which extended into the branch supplying the left upper lobe. Many of the smaller rami were either completely or partially occluded by the continuation of the above described thrombus. The extrapulmonary part of the right pulmonary artery was also dilated forming a sac which had a depth of 3 cm. and a length of 3.2 cm. Its lumen was partially obliterated by a huge thrombus.

The authors believe that the two congenital arteriovenous shunts necessitated increased work on the part of the right ventricle. These shunts were also largely responsible for the pulmonary hypertension shown clinically by the right-sided cardiac enlargement and the accentuated pulmonic second sounds and anatomically by the right ventricular hypertrophy. —*J. J. McCort.*

ABDOMEN

Samuel, Eric. Review of Scandinavian literature on gastrointestinal diseases, 1939–1943. *Brit. J. Radiol.*, July, 1944, *17*, 221–225.

Brief abstracts are given of the Scandinavian literature during this period. Holmgren in an article on sideropenic dysphagia or cancer of the hypopharynx described 2 cases, 1 of which proved to be cancer and the other sideropenic dysphagia. Frostberg recommended examination of the barium-filled esophagus in cases of goiter. Christiansen records 4 cases of short esophagus, 2 in elderly peoole and 2 in infants. In any case of carcinoma of the esophagus at an unusual site the possibility of short esophagus should be considered. Helghe Myhre discussed the significance of large niches in the stomach on the basis of 23 cases from the University Clinic in Oslo. Nine were carcinomatous and 14 benign. If there are no other signs of infiltration ulcers larger than 2.5 cm. in diameter are more apt to be benign than malignant. Forssman discusses 30 cases of benign tumor of the stomach seen in ten years and compares them with 931 cases reported by Muines and Geschickter. The roentgen diagnostic features are: smooth outline of the filling defect, normal movable mucosa over the tumor, large ulcer crater, softness and compressibility of the

tumor and peristalsis of the neighboring mucosa, and mobility of the tumor in relation to the wall of the stomach and the mucosa. Forssman also contributed an article on the roentgen diagnosis and treatment of sarcomas of the stomach, especially lymphosarcomas and reticulum cell sarcomas. The chief roentgen signs of sarcoma are that the growth is in the wall and not in the lumen of the stomach; the mucosa is intact with a bulging outline; the overlying mucosa is smooth; peristalsis is lost in the affected region at an early date and the tumor is centrally placed and the edges are flexible. Roentgen therapy with daily doses of 200–400 r up to a total skin dose of 2,500–3,000 r gives satisfactory results. Holta describes 3 cases of leiomyosarcoma of the stomach and says that roentgen differentiations of one form of benign tumor of the stomach from another is not possible. Nordentoft discusses the value of the barium enema in the diagnosis and treatment of intussusception in children on the basis of 440 cases. The two chief roentgen signs of successful reduction are complete filling of the cecum and inflow of the enema into the small bowel. The danger of rupture of the bowel is theoretical rather than practical. Skarby described a case of roentgen diagnosis of primary invagination of the appendix which he thinks is the first one recorded. Steinert, Hareide and Christiansen discuss the roentgen diagnosis of acute appendicitis on the basis of 104 cases. Fecaliths were found in the appendix in 10 cases. The distribution of gas in the cecum and colon varied greatly. Fluid levels in the cecum are a characteristic finding in acute appendicitis. Fluid and gas levels in the terminal ileum are also characteristic. There was a homogeneous density in the region of the appendix in 34 cases. Free fluid was demonstrated on operation in 83 cases. Free gas in the abdominal cavity is a conclusive sign of perforation. The flank stripe was seen in 6 cases. The psoas outline was obliterated in 13 cases. There was left convex scoliosis in 32 cases; the appendix was perforated in 10 cases, gangrenous in 4 and catarrhal in 3. There was inward bulging of the flank on the affected side in 14 cases. In 14 cases there was reduced excursion of the diaphragm on the left side. The roentgen signs may be visible as soon as four hours after the onset of the illness but in some cases they were not visible after ten hours, Holmgren described 2 cases of volvulus of the sigmoid, 1 of which showed gas and fluid levels in the cecum and the rest of the large bowel. This is unusual. In the other an esophageal tube was passed through the rectum into the twisted loop, resulting in spontaneous reduction of the volvulus. The varieties of volvulus are illustrated. The loop may turn through any degree from 90° to 560°. Renander discusses the roentgen signs of tuberculosis of the rectum. This is rare but does occur and may be primary or secondary. It is generally sclerotic but may be hyperplastic. The rectum is contracted to form a narrow tube with deep excavations in the walls. If the rectum is contractile it indicates tuberculosis rather than carcinoma or syphilis. Buckhuis described a case of fistula between the duodenal cap and the bile duct, reviewing the literature and emphasizing the rarity of the condition. Ollsen discussed nursing as a source of error in cholecystography. The dye is excreted in the milk, causing poor concentration in the gallbladder. Moberg described a case of portal thrombosis which calcified and was diagnosed on the plain film. The article is beautifully illustrated. This case emphasizes the value of the plain roentgenogram of the abdomen. Selander reported 2 cases of embryonic tumor of the sympathetic nervous system, 1 in a child three years of age and the other in a female of twenty; the duration of the disease was two years in 1 case and three and a half years in the other. The condition must be differentiated from mycetoma and small-celled sarcoma and roentgen and even microscopic differentiation may be very difficult.—*Audrey G. Morgan.*

Reinberg, S. A. X-ray diagnosis in gunshot wounds of the abdominal cavity and its significance in field surgery. *Brit. J. Radiol.*, Oct., 1944, *17*, 291–295.

It was not until toward the end of the war of 1914–1918 that surgeons began to recognize the importance of early operation in gunshot wounds of the abdomen; this was necessarily followed by an appreciation of roentgen diagnosis in these wounds, but little could be accomplished at that time on account of the imperfect roentgen apparatus in use.

During peace time of course nothing could be done about abdominal wounds but a beginning was made in the study of peace time abdominal conditions such as gastric and duodenal ulcers and acute intestinal obstruction. During the last few years before the war over 90 per cent

correct diagnosis was achieved in these conditions. This was rendered possible by the establishment of twenty-four hour service which was first instituted in the roentgen department of the Sklifassovsky Institute, Moscow, in 1932. So far as the author knows there is no such service anywhere except in the U.S.S.R. This service was continued after the war began, the soldiers being brought in quickly, generally in the first twenty-four hours, and often by plane.

Roentgen examination is of decisive importance in fixing the differential diagnosis between penetrating wounds, perforating wounds and tangential wounds. This is difficult or often impossible clinically. The roentgen diagnosis of pneumoperitoneum as evidence of injury of the intestine is of great importance. This, too, can often not be detected early by clinical signs. Operation is indicated as soon as it is established. Negative evidence is not always absolutely conclusive.

The condition found in injury of solid organs is hemorrhage and while the nature of an abdominal fluid cannot be demonstrated by roentgen examination it is safe to conclude that fluid in the abdomen soon after an abdominal wound is blood.

It is safe to say that the wider the use of roentgenology in gunshot wounds the greater the absolute and relative numbers of cases correctly diagnosed and properly treated. Of course the full use of roentgenology depends on the possibility of bringing apparatus as near the front line as possible and therefore tactical and administrative problems as well as medical ones are involved.—*Audrey G. Morgan.*

PACK, GEORGE T., and EHRLICH, HARRY E. Neoplasms of the anterior abdominal wall with special consideration of desmoid tumors; experience with 391 cases and a collective review of the literature. *Internat. Abstr. Surg.*, Sept., 1944, *79*, 177–197.

The present report is based on an analysis of 470 tumefactions in the locality of the anterior abdominal wall and includes 391 cases of neoplastic diseases.

Surgical Anatomy. The linea alba (the tendinous raphe which stretches down the middle of the anterior abdominal wall) is not perforated by lymphatic capillaries so that it partitions the deep lymphatic system of the anterior abdominal wall into right and left halves. Thus cross metastases of intramural tumors occur only when a malignant growth is situated behind the transversalis fascia or the posterior rectus sheath, i.e., in the preperitoneal fatty areolar layer—a most unlikely location for a primary lymphatic metastasizing neoplasm.

Benign Tumor. Fifty-one per cent of the 470 tumefactions were benign—constituting the largest group. Of the 305 primary neoplasms, 80 per cent were benign and 20 per cent malignant. The sexes were almost equally affected. The ages of the patients varied from six weeks to seventy-seven years, the average age being thirty-three years.

Thirteen distinct morphological types of tumors were encountered. The common benign neoplasm in order of their frequency were lipomas (20 per cent), neuronevi, hemangiomas, epithelial papillomas, fibromas, neurofibromas, and keratoses or keratotic papillomas.

Primary Malignant Tumors. There were 63 primary malignant tumors. Primary and metastatic tumors occur with about equal frequency in this locality. The anterior abdominal wall is particularly vulnerable to secondary cancerous deposits because of its lymphatic and venous connections, especially with the peritoneal cavity and portal circulation through the umbilicus.

Carcinomas and sarcomas in this area occur with about equal frequency. Out of 17 cases of epidermoid carcinoma, 12 were engrafted on pre-existing tissue abnormalities (sinuses, scars, psoriatic lesions, etc.).

Cancers which have their origin in postoperative chronic draining abdominal sinuses or in laparotomy scars carry a grave prognosis.

Primary sarcomas are more frequently found than primary carcinomas. The more common tumors in order of frequency were neurogenic sarcomas, spindle-cell sarcomas, synoviomas, and rhabdomyosarcomas. The treatment of these tumors must consist of wide resection. Irradiation is a most valuable therapeutic adjunct.

There were 8 primary melanomas, 12.7 per cent of all primary malignant tumors in the anterior abdominal wall. Melanoma offers the gravest prognosis when it arises in the umbilicus. It is best treated surgically.

Metastatic Malignant Tumors. Metastatic cancer is most frequently situated in or about the umbilicus, is frequently multiple, may involve the abdominal wall bilaterally and frequently metastasizes to the regional axillary and inguinofemoral lymph nodes. (The features

of primary carcinoma are the exact opposite of these.)

In 22 cases, the first indication of lymphosarcoma, Hodgkin's disease, leukemia, or mycosis fungoides was tumefaction in the anterior abdominal wall.

Miscellaneous Lesions Simulating Tumors in the Anterior Abdominal Wall. There were 79 cases (16.8 per cent) of such lesions in the series. The most common non-neoplastic lesions are cysts (sebaceous, urachal, and sweat glands) and chronic nonspecific inflammatory masses. Less often encountered are nonmalignant radiation ulcers, fat necrosis, tuberculosis, and endometriosis. There were 2 cases of Boeck's sarcoid.

Desmoid Tumors.

Definition. Desmoid (from *deous*, meaning band and *eidos*, meaning appearance) is essentially a hard fibroma situated in the flat muscles of the anterior abdominal wall. It occurs characteristically in young parous women and frequently recurs following limited surgical removal. It is unencapsulated and infiltrating and of fascial or aponeurotic origin.

Incidence. These tumors are rare. In this series they comprised 3.5 per cent of all tumefactions and 7 per cent of all benign tumors in the anterior abdominal wall.

Causative Factors. None could be determined. The one factor that appears to be of etiological significance is pregnancy.

Anatomy. The growth is almost always solitary and unilateral. These tumors show a tendency to infiltrate into joints and to become adherent to bone. The rectus abdominis was the muscle which was most frequently the site of this tumor. The vascular supply of desmoids is poor. The microscopic appearance is that of a fibroma plus the presence of bundles of striated muscle fibers in various stages of atrophy. The desmoid tumor differs from the ordinary fibroma in that it is often unencapsulated, possesses infiltrative tendencies, and attains considerable size. Characteristically, the desmoid tumor always compresses, invades and destroys muscle.

Diagnosis and Clinical Course. There are no special symptoms characteristic of these tumors. In the majority of the authors' cases, the neoplasm was located in the right lower quadrant. Bouchacourt's sign was demonstrated in almost every case. This sign is revealed by having the patient contract the muscles of the anterior abdominal wall by flexing the head; following this maneuver, an intraperitoneal mass can no longer be palpated or, only very slightly, but an intramural mass becomes more prominent.

Desmoid tumors are slow-growing. Growth is progressive, however, and if of sufficient duration (from seven to ten years), the neoplasm may reach huge proportions, involve the entire abdominal wall, and penetrate into the retroperitoneal space or even into the abdominal cavity and pelvis.

Treatment. The treatment of choice is radical surgical excision. Radiation therapy has a definite place in the management of desmoid tumors (the effect is probably an indirect one due to suppression of ovarian function). This latter form of treatment should be reserved for inoperable cases, large tumors in poor-risk patients, and for those who will not consent to operation.

Prognosis and End-Results. Although desmoid tumors may undergo malignant transformation, no instance was encountered in which there were regional lymph node or distant metastases. In this series there were 4 cases in which the tumor recurred and 1 case in which there were two recurrences. All recurrences responded satisfactorily to radiation therapy.—*Mary Frances Vastine.*

Snell, W. E. Radiographic abnormalities of stomach and colon in mental defectives. *Brit. J. Radiol.*, Aug., 1944, *17*, 239–240.

During the course of miniature chest surveys in 2,035 mental defectives at an English hospital it was found that many of the patients showed an increased gas content of the stomach. Distention of an abnormal degree was found in 109 cases, or 5.3 per cent. Age seemed to have no effect on its incidence but it was almost twice as common in women as in men. The condition was found chiefly in cases of congenital mental defect and it was commoner in the more pronounced types of mental deficiency. This may be due partly to the fact that these patients are more vegetative, many of them being confined to bed. The abdominal walls are relaxed and constipation is common; the increased gas is probably due to general hypotonus of the intestines. Another possible factor is that many idiots have to be fed by attendants and this probably conduces to aerophagy.

In 3 cases out of the 2,085 the colon lay above the liver, separating it from the diaphragm. This condition is called falciform colon

and is due to a congenital defect of the falciform ligament of the liver. Multiple congenital defects are common in patients who are deficient mentally.—*Audrey G. Morgan.*

WILEY, H. M. Gastric ulcer, benign or malignant. *Am. J. Surg.*, July, 1944, *65*, 104–111.

The author bases his report on a group of 43 cases of gastric cancer treated in the Department of Surgery of the Ellis Fischel State Cancer Hospital and considers the subject of relationship and differential diagnosis between gastric ulcer and cancer.

He found the average age to be 51.3 years for ulcers and 64.1 years for cancer but points out that material comes from an older age group. The average duration of symptoms for ulcer was 35 months, for cancer 13.9 months. Symptoms of upper gastric pain and distress, vomiting and weight loss were of little differential value but he believes that "absence of occult blood (in the stools) excludes cancer of the gastro-intestinal tract except that of the infrequent scirrhus form." While achlorhydria is found normally in 35 per cent of individuals in the seventh decade, he believes that an absent or low gastric acidity favors malignancy and that ulcerated gastric lesions with absent or low free hydrochloric acid should be operated upon immediately.

The most important single diagnostic procedure is roentgen examination and by it, in all but 10 per cent of the cases, differentiation may be made between a benign and a malignant lesion but he states operability cannot be determined from roentgen examination. The greatest accuracy of diagnosis is achieved by combined use of roentgen examination and gastroscopy, but usefulness of the latter is limited by difficulty of interpretation and length of study necessary to gain proficiency.

In the author's series 62.8 per cent of gastric cancers were in the prepyloric region, 11.7 per cent were in the fundus, 18.6 per cent involved the entire body of the stomach and 6.9 per cent were in the cardia. From these figures and also the findings of Allen, and of Kirklin and Holmes, he concludes that "resection should be done on all lesions of the greater curvature and prepyloric areas. Lesions on the lesser curvature should be watched carefully and in the age group above fifty years resection is the only safe course." No differential significance can be attached to the size of the lesion either in the roentgenogram or at operation but large ulcers should be resected on the probability that they are malignant.

In spite of consideration of all diagnostic procedures, gastric ulcer or cancer cannot be differentiated in 10 per cent of cases and even at operation it may be impossible to determine the exact nature of the gastric lesion unless rapid frozen sections are studied.

His report includes details of history, examination and final diagnosis of 2 cases. In the first the lesion appeared benign even at operation but the microscopic report showed carcinoma. In Case 11 there was a large perforating ulcer on the posterior aspect of the stomach; this was thought at operation, and confirmed microscopically, to be benign. The article concludes with a well arranged table of useful differential features.—*Angus K. Wilson.*

PREISS, A. Case of peptic ulcer on the greater curvature of the stomach. *Brit. J. Radiol.*, June, 1944, *17*, 182–184.

Peptic ulcer on the greater curvature of the stomach is very rare. David in a survey for the years 1914 to 1928 found only 24 cases reported in the literature. Many cases with the roentgen picture of ulcer and benign macroscopically on operation are found on histological examination to be malignant. Demole and Henny in 1939 stated that only 12 cases have been reported that have been proved microscopically to be benign.

A case is described in a man of thirty-four who had had heartburn frequently since youth and epigastric pain about two hours after meals since 1926. In 1938 laparotomy was performed but there was no history of any surgical operation. From then until 1940 he was free of symptoms but then began again to have severe pain after every meal and often vomiting. Roentgen examination showed the typical appearance of ulcer on the greater curvature with narrow folds converging toward the niche. Roentgenograms and a histopathological picture are given. The patient was under observation and treatment from November, 1942, to February, 1943, when on account of the severity of the symptoms, the failure of the ulcer to heal and the possibility of cancer, operation was performed. It showed a callous penetrating ulcer on the greater curvature; no sign of malignancy or evidence of a previous operation was found. Histopathological examination showed the scar of a healed chronic gastric ulcer with no signs of cancer.—*Audrey G. Morgan.*

Elkeles, A. Radiological observations and the description of a cardiac pouch in carcinoma of the cardiac end of the stomach. *Brit. J. Radiol.*, Aug., 1944, *17*, 251–254.

Diagnosis of cancer of the cardiac end of the stomach is still difficult. The author describes several known roentgen signs of this condition and adds another which if confirmed by other investigators may prove valuable in the early diagnosis of cancer at this site. He found it in all of 5 cases examined. It is a pouch hanging from the lower end of the cardiac end of the stomach below the antrum cardiacum. It is roughly triangular in shape with the greatest density at the apex. It can best be demonstrated in the erect position and remains filled with barium for three and a half to four and a half hours. It must be differentiated from true cardiac diverticulum, which, unlike the pouch, has a uniform round shape, is the size of a cherry or sometimes larger, may be movable is not tender on pressure and holds the barium much longer. The peculiar shape, the unusual position and the pendulous character of the pouch are additional factors in differential diagnosis.

The 5 cases examined are illustrated with roentgenograms.—*Audrey G. Morgan.*

McCarty, Ray B., and Present, Arthur J. Mesenteric pouch hernia simulating paraduodenal hernia. *Surg., Gynec. & Obst.*, June, 1944, *78*, 643–648.

Intra-abdominal hernias are of such rarity that they often escape consideration in the differential diagnosis of acute or chronic intestinal obstruction, or recurrent slight digestive symptoms. A mesenteric pouch hernia occurring in a soldier with a history of three attacks suggestive of volvulus is described. The preoperative diagnosis based on the roentgenographic findings was a probable paraduodenal hernia. Because of the origin of this hernia near the duodenojejunal junction, it is discussed with paraduodenal hernias from the standpoint of etiology, symptomatology, roentgenography, and of treatment.

Etiology. 1. In 1899, Moynihan described 9 "duodenal fossae" in the vicinity of the junction of the duodenum and jejunum, some of which are frequently found, while others are very rare. He described right and left duodenal hernias and expressed the belief that an increase in intra-abdominal pressure started the formation of a hernia provided the proper fossa was present and a loop of small intestine became engaged in the fossa.

2. In 1920, Andrews dissented from this opinion and presented evidence to support his thesis that "duodenal hernia is a congenital anomaly due to imprisonment of the small intestine beneath the mesentery of the developing colon." If rotation of the umbilical loop is not carried to completion he stated that a right duodenal hernia would be produced.

3. In 1935, Callander, Rusk and Nemir reported a case of so-called left duodenal hernia. In the embryological discussion they brought out convincing evidence that this type of large hernia is not a result of incomplete or malrotation but rather the result of invagination of an area of the descending mesocolon medial to the ascending branch of the left colic artery and inferior mesenteric vein by the jejunoileum while the descending colon is mobile and has not as yet fused with the primitive posterior parietal peritoneum.

Symptoms. Mesenteric pouch hernias are reported much less frequently than paraduodenal hernias. However, as the hernia reported here had its origin high in the mesentery to the small intestine in the paraduodenal region and exhibited the same symptoms as might be expected of a paraduodenal hernia, it seems fitting to include this case with paraduodenal hernia in a general discussion of symptoms: (1) bouts of intestinal obstruction; (2) vague, slight gastrointestinal distress; (3) no history of gastrointestinal distress; (4) occasionally, a soft palpable tumor. Percussion should give a resonant note and on auscultation gurgling peristalsis may be heard.

Roentgenography. Presented with the unusual finding of a smoothly outlined, clumped small bowel pattern, and with confirmatory decrease in mobility and motility, the diagnosis of a hernia in the region of the duodenojejunal junction should be suggested. Only by complete so-called "small intestinal" studies can the proper conclusion be obtained. Case and Upson stated that whenever the duodenum goes directly to the right and thence into the jejunum without the normal swing to the left, a paraduodenal hernia should be suspected.

Roentgenographically, the confusing conditions include peritoneal adhesions and a congenitally short mesentery. In the former, a more diffuse pattern is to be anticipated with sharper angulations and segmentations of the involved loops. Palpation, normal progress of

the meal and change in position of the loops in decubitus films should eliminate a short mesentery.

Treatment. The treatment of hernias occurring about the duodenojejunal junction is surgical.—*Mary Frances Vastine.*

FICARRA, BERNARD J., and DEGAN, WILLIAM B. Congenital atresia of the ileum, spontaneous perforation and multiple intussusception. *Am. J. Surg.*, July, 1944, *65*, 123–126.

The authors present reports of 2 interesting surgical conditions which they encountered during their residency in King's County Hospital.

CASE I. This was a premature (eight months) infant who showed on the first post-partum day abdominal distention, unrelieved by gastric or rectal intubation. Clinical and roentgen (plain abdominal film) findings indicated small intestinal obstruction. At operation thirty-six hours after birth there were found (*a*) membranous obstruction of the ileum 3½ inches from the ileocecal valve, (*b*) transverse rupture of the ileum 5 inches from the ileocecal valve, and (*c*) peritonitis. Death occurred ten hours after operation.

In discussion the authors stress the relative infrequency of this type of obstruction and the rarity of perforation proximal to the point of obstruction. They quote a report by Ladd and Gross in which 5 out of 41 similar cases survived operation. They also mention Farber's tests for the microscopic detection of swallowed vernix cells in the meconium; absence of such cells is presumptive evidence of intestinal obstruction.

CASE II. This patient was a twenty-three month old colored male who had constipation for five days prior to hospitalization but on alternate days during this period had passed small amounts of fecal material. Abdominal pain was manifested by flexion of thighs on abdomen, facial expression and holding the abdomen with his hands. Vomiting occurred twice during physical examination. No blood was passed per rectum. Plain film studies of the abdomen showed a soft tissue mass in the right upper quadrant and clinically there was a suggestion of a palpable mass in the right lower quadrant. A clinical diagnosis of intussusception was made. At operation seven days after admission a double intussusception was found, viz., of the terminal ileum into the cecum and of the cecum into the ascending colon. It was noted that there was extreme mobility of the right half of the colon. The obstruction was relieved and the bowel found to be viable. The appendix was removed and the cecum and terminal ileum were sutured to the posterior parietal peritoneum. Barium enema study four days after operation showed a normal large intestine. The authors, in their comment, state that multiple intussusception is usually of the ileo-ileocolic type and that ileo-cecal-cecal colic such as this are extremely rare. They believe that the relatively long, non-fatal progress in their case is indicative of a intussusception which reduced itself and then recurred.—*Angus K. Wilson.*

HENDERSON, NORMAN P. Diverticulitis and diverticulosis. *Brit. J. Radiol.*, July, 1944, *17*, 197–203.

There is considerable confusion in the use of these terms and the author defines diverticulosis as a condition in which herniated mucosal sacs appear inside or outside the wall of the colon. Diverticulitis is an inflammation of such sacs. They may be caused by any condition which weakens the wall of the intestine but he believes they are most frequently produced by one or more attacks of inflammation. However, they may occur in association with cancer of the colon and in such cases he believes that the cancer is present first and weakens the bowel wall so that diverticula develop. This is contrary to the usual assumptionth at the diverticula precede the cancer. In support of his theory he describes a case in which the diverticula first became manifest but a comparison of later roentgenograms with the earlier ones showed that the carcinoma had been present first. These roentgenograms and those of other cases are reproduced and a colored plate is given showing the five stages in the development of diverticula: (1) the ripple border stage; (2) palisading; (3) pulsion diverticula; (4) retractable ballooning, and (5) permanent diverticula. For effective treatment these diverticula should be diagnosed in the early stages before the later and more serious changes develop. If diverticulosis has been diagnosed and no tumor growth found an examination by opaque enema should be made every year for the next three years. Often before the end of this time the development of a carcinoma can be observed. This is a form of preventive medi-

cine and should be practiced just as preventive dental examinations are. In more advanced cases the carcinoma is sometimes actually buried in the area of diverticulosis.

If the diverticulosis does not proceed to the second or palisading stage diverticulitis sometimes causes a fibrosis the final stage of which is a fibrous contraction with stenosis or stricture. —*Audrey G. Morgan.*

James, Charles F., Jr. Dermoid cysts of the mesentery. *Am. J. Surg.*, July, 1944, *65*, 116–119.

The author reviews the literature and reports the sixteenth recorded case of dermoid cyst of the mesentery. His case differs from those previously described in that two cysts were found, whereas, other writers had reported only one. The etiology, though possibly explained by several theories, remains obscure. These cysts may be located in any portion of the mesentery but are most frequent in the lower end of the ileum. The case reported was of a twenty-four year old American soldier who complained of lower abdominal pain, nausea and loss of appetite for two weeks; these complaints were sufficiently severe for two days preceding hospitalization to require medical consultation. There was slight weight loss but there were no symptoms indicative of gastrointestinal or urinary tract involvement. Temperature on admission was 100.5° F., pulse 100, erythrocyte count 4,840,000, hemoglobin 95 per cent, leukocyte count 20,000, with 86 per cent polymorphonuclears. There was a tender, fixed mass which occupied the right lower quadrant of the abdomen and extended across to the left of the umbilicus. On rectal examination it was high on the right side and outside of the rectum. The findings pointed to a probable appendiceal abscess and it was decided to postpone operation until this had been given an opportunity to become walled off. During the subsequent forty-eight hours, on a regimen of chemotherapy and intravenous feedings, the leukocyte count dropped to 9,000 with 71 per cent polymorphonuclears. Six days after admission the mass had changed in position and was ballotable. A plain roentgenogram of the abdomen showed a large, sharply defined, ovoid mass containing numerous areas of calcification in the right lower quadrant. It was not attached to bone and barium enema examination showed it outside of the colon.

From the roentgen studies a preoperative impression of dermoid cyst was made and this was confirmed at operation, when two masses were found, one measuring 2 by 4 inches and the other 2 by 3 inches; they were approximately 3 inches apart in the mesentery of the distal 2 feet of the ileum. The smaller one had perforated and some of its contents had caused a localized peritonitis. The preoperative impression was confirmed by pathological study of the removed tissue.

The author points out that symptoms in association with mesenteric dermoids are due to complications such as obstruction by kink, volvulus, intussusception or torsion; peritonitis; or hemorrhage by sloughing of a blood vessel.

The patient concerned in this report made an uneventful recovery.—*Angus K. Wilson.*

Edmondson, Hugh A., and Berne, Clarence J. Calcium changes in acute pancreatic necrosis. *Surg., Gynec. & Obst.*, Sept., 1944, *79*, 240–244.

Langerhans showed that the lesions of fat necrosis consisted of calcium soaps resulting from the enzymatic effect on netural fats. He further showed that the glycerol by-product was absorbed without recognizable effect. It would seem that systemic effects might follow the dislocation of large amounts of calcium from the blood stream into the areas of fat necrosis.

The observation of a patient with fatal acute pancreatic necrosis in whom tetany existed with normal blood carbon dioxide combining power led to quantitative determinations of blood and tissue calciums which furnish the data upon which this report is based.

Materials and Methods. In the study a group of patients seen at the Los Angeles County Hospital was utilized. Three phases of study were carried out: (1) The total amount of calcium deposited in and around the pancreas in patients upon whom necropsy was done following death from acute pancreatic necrosis was estimated. (2) Measurements of the total blood calcium on patients with acute pancreatic necrosis were made. (3) Measurements of diffusible and nondiffusible calcium in patients who were known to have lowered total serum calcium were made.

Analysis of Study.

1. The amount of dislocated calcium found in and around the pancreas in 6 fatal cases of

acute pancreatic necrosis was found to be equal in amount to more than twice that present in the normal circulating blood.

2. The findings of low serum calcium levels in all severe cases of pancreatic necrosis would imply that the large loss into the tissues is not readily compensated for by mobilization of calcium from normal body stores.

3. The increased percentage of diffusible serum calcium appears to be compensatory to this lowering of the total serum calcium.

4. The authors have seen no severe cases of pancreatic necrosis in which the serum was not lowered. They have thus added a laboratory finding which tends to substantiate the elevations of blood and urinary diastase.

5. A number of patients with perforated duodenal ulcer were found to have high blood amylase levels and lowered serum calciums. These changes are physiologically consistent since fat necrosis may also be present in perforated duodenal ulcer.

6. Those patients whose serum levels were between 7 and 8 mg. per 100 cc. of serum invariably presented a very severe form of the disease. Such an index of tissue injury may furnish a basis for establishing the diagnosis of acute pancreatic necrosis as distinguished from the so-called acute pancreatic edema. Prognostic importance of the serum calcium level is indicated by the fact that death occurred in all patients in this group whose serum calcium level fell below 7 mg. per 100 cc.

7. The amount of diffusible serum calcium tends to remain stable in the presence of a decrease in total serum calcium.—*Mary Frances Vastine.*

Kohn, Schuyler G., Briele, Henry A., and Douglass, Louis H. Volvulus complicating pregnancy. *Am. J. Obst. & Gynec.*, Sept., 1944, *48*, 398–404.

Volvulus occurring with pregnancy is a very interesting and a very rare complication. There have been only 6 cases reported in the United States and 73 cases reported abroad. The authors have studied 18 cases of volvulus complicating pregnancy including 2 original cases. They make the following observations:

The etiology of this complication (volvulus) is not clear and the only relatively consistent pathologic finding is an elongated mesocolon in those cases involving the sigmoid colon.

In all the cases reported the site of the volvulus was as follows: (1) small intestine—19 cases, (2) large intestine other than sigmoid—19 cases, (3) sigmoid—41 cases.

The diagnosis of volvulus is very difficult but intestinal obstruction is usually quite apparent.

The symptoms are those of obstruction depending upon the location of the blockage.

The prognosis for mother and child is good if early diagnosis and treatment are available.

The treatment is surgical relief of the obstructing volvulus. Termination of pregnancy does not appear to be indicated.

It would seem that large doses of corpus luteum substance pre- and postoperatively are of considerable help in allaying the sensitivity of the uterus in the first and second trimesters, when laparotomy is done, but of doubtful value in the third trimester.—*Mary Frances Vastine.*

Yater, Wallace M., and Coe, Fred O. Ten years' experience with thorotrast hepatosplenography. *Ann. Int. Med.*, March, 1943, *18*, 350–366.

In a review of the literature the authors find that in recent years a large number of articles have appeared in the medical literature condemning the parenteral use of thorotrast because of supposed latent radioactivity or because of neoplastogenic properties of thorotrast deposited in the subcutaneous tissues. Practically all of these reports are based upon animal experimentation. On the other hand, no reports by clinicians have been found showing any serious ill effects as the result of the use of thorotrast. The following technique was used. The average dose employed has been 75 cc., given intravenously, usually in divided doses of 25 cc. on each of three successive days, the roentgenogram being made on the fourth day. However, the entire amount may be given at one time without danger and good roentgenograms may be obtained as early as one and three-fourths hours later.

Two hundred and eighty-six cases were examined by this method over a period of more than ten years. Of these patients 10 were known to have lived for more than ten years, 5 between nine and ten years, 3 between eight and nine years, 5 between seven and eight years, 3 between six and seven years, 4 between five and six years, 6 between four and five years, 10 between three and four years, 10 between two and three years and 12 between one and two years. No immediate or remote ill effects of importance have been observed. There has been no evidence of latent radioactivity, depression of

hepatic or splenic or hematopoietic function, lowered resistance to infection, or development of malignant neoplasia at the site of injection.

Hepatosplenography is said to be of definite value (1) in helping to diagnose cirrhosis of the liver; (2) to determine the presence of metastasis to the liver; (3) in the diagnosis of abscess of the liver.

The authors warn that care should be taken to inject thorotrast into the veins and not into the adjacent tissues, not because of the possibility of development of neoplasm but in order to prevent the formation of nodules and to save the vein.—*J. J. McCort.*

Best, R. Russell. The incidence of liver stones associated with cholelithiasis and its clinical significance. *Surg., Gynec. & Obst.*, April, 1944, *78*, 425–428.

The incidence of cholelithiasis in adults is probably between 20 and 30 per cent. The high incidence of common duct stones in cases of cholelithiasis has been fully appreciated only during the last fifteen years. In the past, continued or recurrent biliary distress following cholecystectomy has too frequently been attributed to liver dysfunction, hepatitis, cholangitis, pancreatitis, or partial injury to the common duct, when as a matter of fact it was due to a stone in the common duct. It is estimated that in 1 of every 4 or 5 cases of cholelithiasis stones will be found in the common duct.

The author believes that sooner or later every surgeon will encounter one or more cases in which he feels satisfied in his own mind that the common duct has been thoroughly explored and all stones and debris removed, only to find that later, at a necessary secondary operation, another stone is present. There is no doubt that there are elusive stones in the common duct, especially at the lower end where at times they seem to seek a small diverticulum and avoid the exploring forceps, probe or irrigator. Again, stones may form from minute particles of debris or precipitate in the choledochus. However, the writer believes that another definite source of so-called recurrent or remaining common duct stones is hepatic. These stones are present in the liver at the time of the original operation and, for one reason or another, become dislodged from the intrahepatic ducts following cholecystectomy.

In 30 cases of cholelithiasis, the liver was sliced thin enough so that all intrahepatic ducts were opened and any stone resting in a duct could be identified. In 2 of these cadavers, stones were found within the intrahepatic ducts. The literature on this subject was then reviewed and it is concluded that the average incidence of liver stones, together with cholelithiasis, is 7.4 per cent. It is suggested that the three day biliary flush be given to all patients before any biliary tract operation in the hope of flushing these liver stones into the common duct where they will be accessible at the first operation, thereby avoiding the second.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

Hartley, J. Blair. The future of radiology in obstetrics. *Brit. J. Radiol.*, Aug., 1944, *17*, 241–246.

There are a number of fields in which accuracy may be reasonably expected in roentgen examination in pregnancy, such as demonstration of fetal parts at sixteen weeks or more, estimation of fetal maturity, demonstration of fetal death, presentation and position of fetus, demonstration of bony pelvis, pelvimetry, size and shape of uterus, and detection of fetal deformities. In another group the report may be accurate but incomplete, as in detection of fetus, estimation of disproportion, diagnosis of extrauterine pregnancy, diagnosis of associated tumor and pregnancy, cause of non-descent of fetal head into pelvic inlet, demonstration of placental site, diagnosis of post-maturity and diagnosis of minor fetal defects and deformities.

Even greater usefulness is to be expected from roentgenology in the future, however, with the development of improved apparatus and technique. Relatively unexplored fields that should be studied are a study of the exact mechanism of labor, estimation of moulding, study of laws of heredity by examining cases of craniolacunia, craniostenosis, hydrocephalus, anencephaly, spina bifida and other abnormalities. These records should be followed through several generations. It should also be possible to study the causes and significance of hydrocephalus and hydramnion, to identify the site of the placenta accurately before birth and to study the normal development of the skull bones, particularly those of the vault. Mass roentgenography of primiparae and even of infants may prove valuable.

The author advocates the establishment of a National Institute for the study of obstetrics and heredity in which obstetricians and roent-

genologists shall cooperate closely, not only in examining individual cases but in keeping records over generations of the obstetrical history of families. There should be what he calls an outer ring for routine examinations and an inner ring for research teaching. He thinks a great deal could be accomplished in improving public health in this way.—*Audrey G. Morgan.*

Hastings, W. H. Precise pelvimetry. *Brit. J. Radiol.*, Aug., 1944, *17*, 259–260.

A method of pelvimetry was described in this journal in April, 1942, p. 114, which seems to have proved successful. In this article a table of reduction factors is given which will be a useful supplement to it when the tube-shift is 3 inches.

The important measurement in square measure of the inlet is quickly made by multiplying the product of the transverse and obstetrical conjugate diameters (measured in inches) by 5 and adding 1.5 which gives the measurement in square centimeters. For the outlet the measurements of the pubosacral and bi-ischial diameters are used. A form of report of the different measurements taken is given.—*Audrey G. Morgan.*

Williams, E. Rohan. Venous intravasation during utero-salpingography. *Brit. J. Radiol.*, Jan., 1944, *17*, 13–17.

During uterosalpingography iodized oil may enter the uterine venous sinuses and pass into the uterine veins in the broad ligaments. Several such cases have been reported and while as a rule the results are not serious, 1 or 2 cases of death from oil embolism have been reported. Therefore care should be taken to prevent this occurrence.

This venous intravasation may be caused by direct injury to the uterine mucosa by the tip of the cannula, by injection at excessively high pressure, by injection when the endometrium is physiologically deficient as it is during menstruation and for six to eight days thereafter and by injection soon after surgical trauma such as curettage or dilatation of the cervix.

The author describes and gives roentgenograms of 5 cases, in 4 of which the injection was given before post-menstrual regeneration was complete and in 1 immediately after a dilatation. After the paper was written he saw a sixth case in which salpingography was performed on the seventh day after a curettage.

To prevent this accident uterosalpingography should not be performed until at least eight days after the end of the menstrual period, until full regeneration after curettage nor immediately after dilatation of the cervix. The author usually practices a fractional injection technique under screen control and under these circumstances a slight degree of intravasation may be seen as a fine network confined within the walls of the uterus.—*Audrey G. Morgan.*

Brody, Samuel. Postmenopausal ovarian carcinoma. *Am. J. Obst. & Gynec.*, Sept., 144, *48*, 417–421.

The "silent" ovarian tumor has long been recognized as a great menace in the control of cancer by early recognition and treatment. The new growth is either discovered accidentally, in the course of a routine pelvic examination, or when the tumor becomes extensive enough to be noticed by the patient or to cause pressure symptoms, at which time it is usually beyond surgical interference.

The fact that a patient has received radium treatment for benign menopausal bleeding does not insure her against the development of other pelvic pathology even in the absence of bleeding. In order to further emphasize this point a case is reported. This patient, a fifty-six year old white female, received radium for uterine bleeding in 1941. The diagnostic curettage showed no evidence of malignancy. The patient was seen again in 1944 because she was complaining of pain in the abdomen. A laparotomy was done and bilateral papillary cystadenocarcinoma of the ovaries was found.

The castrating dose of radium (1,950 millicurie-hours) which was given to the patient in order to suppress the activity of the ovaries and secondarily eliminate their proliferating influence upon the endometrium, had its desired effect. This is evidenced by the atrophy and almost complete absence of the endometrium as shown in the specimen removed, and by the cessation of bleeding, clinically.

However, the irradiation had no inhibiting effect upon the later development of a neoplasm in these ovaries.

It is important to bear in mind the possibility of such a consequence in a postmenopausal patient who has received radium treatment for bleeding and is apparently cured. Such patients, as well as others under observation, should be examined at frequent regular intervals for any pelvic pathology.—*Mary Frances Vastine.*

McGoldrick, Joseph L., and Lapp, Warren A. Theca-cell tumors of the ovary. *Am. J. Obst. & Gynec.*, Sept., 1944, *48*, 409–416.

Although fibromatous ovarian tumors associated with menstrual irregularities of postmenopausal bleeding had been reported previously in the scientific literature, it was not until 1932 when Loeffler and Priesel presented 6 cases of "fibroma theca cellulare xanthomatodes ovarii" that gynecologists and pathologists recognized a new clinical entity. To date, a total of approximately 82 such tumors have been reported in the world literature.

Histogenesis. There are two views as to the origin of the theca-cell tumor: (1) Embryonic ovarian mesenchyme (having a common origin with the granulosa-cell tumor). (2) Unused and immature theca cells of the ovarian parenchyma (and therefore a separate entity from the granulosa-cell tumor).

Clinical Features. Sixty-five per cent of theca-cell tumors occur after the menopause and 35 per cent occur in the period between puberty and the climacterium. The tumor has never yet been demonstrated in children.

If the tumor occurs during the years of normal sexual activity there may be menorrhagia often preceded or succeeded by a period of hypomenorrhea or amenorrhea. Sometimes there are no menstrual irregularities. Varying degrees of virilism have been reported in 3 instances.

Atypical bleeding is the most prominent symptom in postmenopausal patients. Other changes noted are a rejuvenation of atrophic breast tissue, recrudescence of libido, and a revitalization of the vaginal mucosa.

Physiologically, because of the hyperestrinism produced by the tumor, the uterus becomes enlarged and softened, with a glandular cystic or adenomatoid hyperplasia of the endometrium.

Pathology. The tumor is always unilateral. Thecoma tends to simulate fibroma of the ovary in size, shape and consistency. A capsule is commonly present. On cut section, the surface is seen to be composed of varying-sized islands having a diagnostic yellow hue and separated by grayish-white fibrous bands. Small cystic areas are an inconstant feature and result from liquefaction necrosis. Histopathologically, the tumor is composed of interlacing fasciculi of connective tissue scattered through which are nests of polygonal or large spindle cells having an epithelioid appearance.

Treatment. At the most, theca-cell tumors are a form of low grade ovarian malignancy. Most surgeons feel that treatment need not be radical, a simple excision of the ovary being sufficient in the vast majority of cases. Theca cells are considered to be radioresistant, so that radiation therapy is generally considered to be of little or no value except for the diminution of the size of the tumor by the effect of roentgen radiation on the fibrous tissue stromal elements.

Summary. The authors have reported 4 additional examples of theca-cell tumors of the ovary. All the tumors were benign. One very large tumor occurred in a seventeen year old girl, producing no menstrual irregularities. One tumor associated with a fibroma of the opposite ovary showed infarction due to torsion of its pedicle.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

Nation, Earl F. Renal agenesia; study of thirty cases. *Surg., Gynec. & Obst.*, Aug., 1944, *79*, 175–181.

Definition. Agenesis denotes the complete lack of development of the metanephros on one or both sides. The presence of a vestige of renal tissue should classify a case as one of aplasia, not agenesia.

Another differentiation that must be made is between the absence of a kidney on one side due to agenesia and that due to crossed ectopia. If there is evidence that the kidney tissue present on only one side developed from the renal blastema of both sides the condition is one of crossed ectopia, not of unilateral agenesia. In such a case there will be a ureter opening into each side of the trigone.

Embryology. The kidney is formed from a cap of mesoderm, the metanephric blastema, about the ureteral bud. The differentiation of this nephrogenic blastema begins with the growth of the ureteral bud into it. The latter sprouts from the dorsal surface of the wolffian duct near the cloaca during the fourth week of retal growth.

Etiology. The fundamental cause of renal agenesis is probably to be found, in most cases, in defective germ plasm. The complete absence of the ureter in most cases of renal agenesis indicates that the usual cause of agenesis is faulty development of the urinary organs which precede the ureteral bud. The absence of the suprarenal gland on the same side as the kidney is not a necessary concomitant for the diagnosis of renal agenesia.

Analysis and Discussion of Unilateral Agenesia.

1. Sex. There were 18 (67 per cent) males and 9 (33 per cent) females. In the Los Angeles County Hospital autopsies, unilateral and renal agenesia was approximately 20 per cent more common in men than in women.

2. Race. All reported here were Caucasian.

3. Age. There were no significant age distributions for the autopsy cases except for a considerably higher death rate under one year of age. The youth of the patients of the clinical series indicates a tendency for urinary tract pathology, or of the concomitant congenital abnormalities, to make themselves known early in life.

4. Urinary tract. The right kidney was absent in 14 cases and the left in 13. The ureter and the corresponding half of the trigone were totally absent on the side of the renal agenesis in 21 cases (77 per cent). The solitary kidney was enlarged in all but 4 cases.

In 11 cases (41 per cent) there were congenital abnormalities of the solitary kidney or ureter. There were 3 instances of partial duplication of the ureter.

In 3 (19 per cent) of the autopsy cases, besides the 3 with aplastic solitary kidneys, the cause of death was renal failure: 2 renal tuberculosis and 1 chronic glomerulonephritis.

In 6 cases (22 per cent) there were developmental defects of the genital organs.

There is little hope of distinguishing renal agenesia from renal aplasia clinically with any degree of certainty. Absence of one-half of the trigone is much more indicative of agenesia than of aplasia. Absence of one ureteral orifice, or representation of the orifice by a mere dimple, or termination of the ureter just beyond the bladder wall occur more commonly with renal agenesia than with renal aplasia.

Summary.

Three cases of bilateral renal agenesia from a series of 27,000 autopsies are reported.

Twenty-seven cases of unilateral renal agenesia are reported. This number includes 6 clinical cases reported by the author.—*Mary Frances Vastine.*

Herger, Charles C., and Sauer, Hans R. Cortical kidney tumor—analysis of 100 consecutive cases. *Surg., Gynec. & Obst.*, June, 1944, *78*, 584–590.

During the past twenty years, 100 patients with malignant cortical tumors of the kidney were admitted to the urological service of the New York State Institute for the Study of Malignant Diseases. Metastases or evidence of local recurrence at the time of admission were demonstrable in 53 of the cases; 23 of them underwent nephrectomy or exploratory operation elsewhere prior to admission. The object of this study is intended to analyze the material as to history, symptoms, and clinical course.

Sex and Age. Among the 100 patients, there were 65 males and 35 females. The age for these patients varied from seventeen to seventy-five years with 89 patients between forty and sixty-nine years.

Situation and Pathology. Sixty-one of the tumors originated in the right kidney and only 39 in the left kidney.

Microscopic sections were available in only 45 cases. The following types of tumor were identified: hypernephroma, 16; papillary adenocarcinoma, 24; carcinoma, 4; sarcoma, 1. Four of the 100 patients showed evidence of double primary malignant neoplasm.

Symptoms. The classic triad of symptoms—pain, hematuria, and tumor—is encountered as a rule in far advanced cases only. In this series, pain, hematuria, and tumor were present in 31 of the 100 patients. All of them had far advanced and inoperable lesions. Hematuria alone (15 cases) or in combination with pain (6 cases) or tumor and pain (31 cases) was present in 52 patients. The most favorable prognosis as to possibility of cure was offered by the group of 15 patients with painless hematuria only.

There is a certain number of cortical tumors of the kidney which, in spite of definite histopathological evidence of malignant new-growth, show very slow progress of the disease. These tumors have little tendency to perforate the kidney capsule and, if metastases develop, even the metastases have little tendency to progression. Some of these tumors may not affect the wellbeing of the patients for many years because they exert little toxic effects.

Metastases. Metastatic spread of the disease was demonstrable in 60 of these 100 patients. The organs involved in order of frequency were: lungs, 29; bones, 20; liver, 8; distant lymph nodes, 7; mediastinum, 6; vagina, 4; skin, 3; adrenals, spleen, cervix, uterus, and urethra, 1 each.

Metastases from parenchymal renal tumors are of frequent occurrence. This is largely due to the fact that kidney tumors have a tendency

to invade the renal vein even in the early stages of the disease.

Symptoms from metastatic lesions were the first indication of the presence of the tumor in 17 per cent of the 100 patients comprising this study. The fact that 10 of these 17 patients had initial symptoms due to bony metastases suggests that, in spite of the absence of symptoms pointing to the possible presence of a kidney tumor, a complete urological examination should be carried out in all patients with obviously metastatic bone lesions of unknown primary origin.

Treatment. Surgery offers the only chance of cure, provided the tumor is still operable. External radiation treatment is of little or no value in the majority of the cases because parenchymal neoplasms of the kidney are radioresistant.—*Mary Frances Vastine.*

HAAS, R. L. Genital tuberculosis in the female. *Am. J. Obst. & Gynec.*, July, 1944, *48*, 69–74.

Data are presented on 62 cases of proved genital tuberculosis admitted to the University of Michigan Hospital during the last twenty years, with follow-up studies on all cases. The following conclusions are reached:

1. There were no clinical signs or symptoms pathognomonic of pelvic tuberculosis.

2. Sixty per cent of the patients were in the childbearing age.

3. Forty-three and one-half per cent of the married patients had not conceived.

4. One-half of the patients (51.6 per cent) revealed no evidence of active extragenital tuberculosis.

5. When operative treatment is indicated, all the genital organs including the cervix should be removed, even though the latter appears normal grossly.

6. Wound complications (infection and fistulas) are much more common after incomplete operations.

7. Seventy-four per cent of the patients in this series are alive, an average of 10.5 years after their first admittance.

8. Fifty-four per cent of the survivors claim good health with no untoward symptoms.—*Mary Frances Vastine.*

DOCKERTY, MALCOLM B., and MASSON, JAMES C. Ovarian fibromas; clinical and pathologic study of 283 cases. *Am. J. Obst. & Gynec.*, June, 1944, *47*, 741–752.

Exactly two hundred years have elapsed since Astruc in 1743 gave to the medical literature the first description of an ovarian fibroma. The author's report on ovarian fibromas is based on the study of 312 of these tumors occurring in a group of 283 patients. The following conclusions are reached:

1. Ovarian fibroma is the second commonest of the solid ovarian neoplasms. Three hundred and twelve of these tumors accounted for 5 per cent of all ovarian tumors surgically removed at the Mayo Clinic.

2. Ovarian fibroma was never encountered before the age of puberty and this observation has been taken to indicate an origin possibly based on a desmoplastic reaction to the hemorrhage of ovulation or ovarian endometriosis.

3. Ovarian fibroma did not produce any specific diagnostic symptoms.

4. Fifty-one cases had abdominal ascites and 2 cases presented hydrothorax (Meigs' syndrome) suggesting a malignant process. However, these patients never presented the picture of cachexia.

5. The complications of these tumors were chiefly those associated with twisting of the pedicle of the tumor—a phenomenon which rarely occurred until the tumor outgrew the confines of the true pelvis.

6. Pathologically, most of the tumors were solid throughout, white and usually invested by a smooth capsule free from adhesions. Many of the tumors were edematous and a number of these had undergone degenerative changes with central cysts.

7. In 90 per cent of the cases the tumor was unilateral.

8. Bilateral fibroma-like tumors sometimes proved to be metastatic tumors of the Krukenberg type with the primary neoplasm most frequently in the stomach. A yellowish color suggested theca-cell tumor, especially in cases in which the uterus was large and postmenopausal bleeding was noted clinically. In others the yellow color resulted from fatty metamorphosis. A grayish-brown color and firm consistency were noted in several tumors that later proved to be of the Brenner type. A brownish color and soft consistency indicated malignant change, which occurred in 1 per cent of the tumors studied.

9. Microscopically, both cellular and fibrous types appeared to arise from the spindle cells of the ovarian cortex with hemorrhage as a possible inciting element. Degenerative changes, such as fatty, fibrous, hyaline and calcareous,

took positions of importance secondary to the phenomenon of intercellular edema, which correlated more universally than did gross edema and formation of cysts with the clinical production of ascites.—*Mary Frances Vastine.*

NERVOUS SYSTEM

LAGOMARSINO, ENRIQUE H., and DAL LAGO, HECTOR. Las lesiones medulares en los traumatismos cervicales. (Lesions of the spinal cord in cervical trauma.) *Rev. ortop. y traumatol.*, Oct., 1943, *13*, 95–106.

Traumatic lesions of the spinal cord may occur without injury of the vertebrae. Two cases are discussed in young men of nineteen who fell from a height during exercises and struck on the head with the neck in extreme flexion. Both showed quadriplegia at first; roentgen examination was negative. Complete functional restitution was brought about in one case while in the other flaccid diplegia of the arms and slight spasticity of the legs without Babinski sign or sensory phenomena persisted.

A detailed analysis is given of the mechanism of cervicocephalic hyperflexion and photographs and roentgenograms given showing the exact position of the different parts of the vertebrae in each phase of the movement. Longitudinal forces act on the cord, elongating it, and anteroposterior forces, compressing it. This may result in contusion, concussion or elongation of the cord. Hematomyelia may occur in either contusion or elongation of the cord.—*Audrey G. Morgan.*

SPURLING, R. G., and SCOVILLE, WILLIAM B., Lateral rupture of the cervical intervertebral discs. *Surg., Gynec. & Obst.*, April, 1944, *78*, 300–358.

The primary purpose of this report is to call attention to the rôle of the lower cervical intervertebral discs in the production of shoulder and arm pain. The data upon which statements are based were collected from 12 verified cases of ruptured cervical discs.

Anatomy and Physiology. The cervical roots, unlike the dorsal and lumbar roots, emerge from the dura mater at right angles and lie immediately over the intervertebral discs. As a consequence, a lateral protrusion of a cervical disc may compress the nerve root against ligamentum flavum, lamina, pedicle, or facet without much damage to the spinal cord.

Pathology. Degenerative processes play an important rôle in the production of the lateral rupture of the cervical intervertebral disc. This is indicated by the frequency with which there is roentgen evidence of localized arthritic spurs and narrowing of the intervertebral disc at the site of the lesion.

Signs and Symptoms. The fifth cervical disc. (*a*) Pain radiating from the neck into the shoulder and arm with paresthesias (needles and pins or numbness) into the posterior aspect of the thumb. Symptoms are always aggravated by tilting the head to the painful side. (*b*) Weakness or absence of the tendon reflex of the biceps brachialis muscle.

The sixth cervical disc. (*a*) Pain radiating from the neck into the shoulder and arm with paresthesias into the index, middle, and perhaps the ring fingers and tip of thumb. Symptoms aggravated by tilting head to the painful side. (*b*) Weakness or absence of the tendon reflex of the triceps brachialis muscle.

Differential Diagnosis. (1) Bony lesions of the cervical spine, either neoplastic or inflammatory may cause radicular pain similar in every respect to cervical disc lesions. (2) Neoplasms of the spinal cord, particularly those arising from the nerve roots, may give identical symptoms. (3) Scalenus anticus compression, with or without cervical rib, is the lesion most easily confused with ruptured cervical discs. It is to be remembered that the nerve pain from scalenus anticus compression is ulnar in distribution while that in the cervical disc pain is of median or radial nerve distribution. (It should not be forgotten that any lesion of the cervical spine may produce spasm of the scalenus muscle. It is not uncommon, in fact, to have the clinical features of a ruptured cervical disc overshadowed by a superimposed scalenus syndrome.)

Roentgen Examination. (1) The lateral roentgenograms usually show narrowing of the interspace with loss of the normal lordotic curve even in a hyperextended position. (2) Oblique views may show narrowing of the intervertebral foramen with proliferation of bone in the foramen (osteophytes). (3) Pantopaque myelography is an exceedingly accurate method of diagnosing ruptured cervical discs.

Treatment. Conservative treatment relieves symptoms in many cases (bed rest with halter traction). When conservative measures fail, operative removal of the lesion is justified on the basis that it is a simple, safe procedure, and

the results are excellent. Of the 12 patients operated upon at the Walter Reed General Hospital, all have been relieved of their radicular pain within two weeks following operation.

Observations. (1) The cervical disc lesions occur more frequently in the upper age group. This is in contrast to the younger age group in which ruptured lumbar discs are seen. (2) Twice as many ruptured discs occur at the sixth interspace as at the fifth interspace. (3) Unlike the lumbar disc lesions, trauma does not play a prominent part in the etiology of cervical disc lesions.—*Mary Frances Vastine.*

Love, J. Grafton. The differential diagnosis of intraspinal tumors and protruded intervertebral disks and their surgical treatment. *J. Neurosurg.*, July, 1944, *1*, 275–290.

From an analysis of 26 cases in which intraspinal tumors masqueraded as protruded intervertebral discs, and from his experience, Love outlines the differential diagnosis of these two conditions. Males predominate almost three to one in the disc cases while sex distribution approaches equality in cord tumor cases. No significant difference in age groups was noted in this study. Antecedent trauma in cases of protruded discs is well established; it may initiate symptoms of a cord tumor, however, Neurological signs predominate in tumor cases, while physical signs such as limitation of spine movement, limping, a positive straight leg raising test, etc., predominate in the other group. In both conditions the spinal fluid protein is elevated usually above 40 mg. per 100 cc., is rarely over 100 mg. per 100 cc. in disc cases but may be much higher with tumors averaging in this series over 1,400 mg. per 100 cc. Xanthochromic fluid is often seen with tumor cases in the presence of subarachnoid block. Pain is more often unilateral with a disc, the onset of illness more abrupt. Preliminary studies with ordinary roentgen examinations often differentiate the conditions such as the demonstration of bone erosion by tumor. A differential lumbar puncture using two needles one above and one below the tumor is helpful. About 85 per cent of protruded discs are removed by the interlaminal approach while tumors require the removal of one or more laminae. Hemostasis is of great importance in the surgical treatment of both lesions.

While Love admits the unreliability of air spinograms and acknowledges the value of opaque myelography as a means of differentiation of these conditions, he feels that certain dangers are present in the use of non-absorbable media in the presence of elevated spinal fluid proteins. He apparently is cautious about their use. [This paper was prepared before the general availability of absorbable media and the perfection of complete aspiration techniques of spinal subarachnoid contrast media.]—*Leo A. Nash.*

Shinners, Burton M., and Hamby, Wallace B. The results of surgical removal of protruded lumbar intervertebral discs. *J. Neurosurg.*, March, 1944, *1*, 117–122.

In the period from 1937 to July, 1943, 127 examples of protruded intervertebral discs were found in 140 patients at 160 operations including those with multiple lesions and recurrences. In 91 of the 140 patients, 100 spinograms were done using lipiodol, air or thorotrast. Of these, 69 per cent were proved correct, 20 per cent were false positives and 11 per cent were false negatives. In the last few months of this study, spinograms were almost completely abandoned. In the series a progressively smaller exposure was made down to an interlaminal approach and the later cases had tantalum powder implanted in the disc sinus as a signal for possible recurrence. In 116 patients with protruded discs, 13 fusions of the spine were done if instability of the back was present as determined by orthopedic consultation. Of 87 cases traced, 49.5 per cent considered themselves cured, 48.3 per cent improved and 2 cases thought themselves to be worse. Of 7 patients fused and traced, 5 were free of pain and working and 2 did not reply to that portion of the question form submitted. Of 5 not relieved by disc operation and who were later fused, 3 obtained relief. Fifty-four per cent of all cases had residual back or leg pain and 57.3 per cent had back or leg pain while working. The subjective results of private cases and compensation cases correlated very highly except that the former returned to work earlier. Ninety-two per cent were glad they had had the operation.—*Leo A. Nash.*

SKELETAL SYSTEM

Doel, Geoffrey. Further notes on the structure and function of the intervertebral disc. *Brit. J. Radiol.*, Aug., 1944, *17*, 255–256.

The author has been making a study of the

intervertebral disc based on anatomical, physiological and mechanical data. He is in disagreement with some of Schmorl's findings, especially his claim that the nucleus pulposus has the quality of turgor, that is ability to increase its own volume. Ffrancon Roberts has refuted this theory but he claims that the annulus fibrosus has the property of tonus. This is equally false. The annulus has no muscular or nervous elements and therefore it cannot possess tonus. No forces are produced inside the joint. The pressure within the disc which keeps the joint apart and which sometimes extrudes the pulpy nucleus is produced by external forces, including the tonus of the paravertebral muscles, the weight of the body tissues in the erect position and atmospheric pressure acting through the whole body.—*Audrey G. Morgan.*

Peck, Franklin B., and Sage, Charles V. Diabetes mellitus associated with Albright's syndrome (osteitis fibrosa disseminata, areas of skin pigmentation, and endocrine dysfunction with precocious puberty in females). *Am. J. M. Sc.*, July, 1944, *208*, 35–45.

This is a report of a case of diabetes mellitus associated with Albright's disease. There have been no previous cases reported in the literature and in the group of cases collected by Dr. Albright, numbering more than 50, no association with diabetes was noted. It is of interest that in this case the roentgenograms of the skull are suggestive of osteitis deformans, as these cases are frequently seen to exhibit abnormal glucose tolerance curves. Albright has stated that the roentgen examination presents three features which distinguish this disease from hyperparathyroidism: (1) there are areas of increased density and overgrowth of bone as well as decreased density; (2) the condition is not generalized and one should be able to find parts of the skeleton which are perfectly normal; (3) the disease practically never involves the epiphyses. No etiological conclusions were drawn by the author on this one case since diabetes develops in one of 200 to 250 persons in the population and there is a history of diabetes in the patient's family.

A twenty-two year old white male was admitted with diabetes and coma. There were brownish pigmented areas on the skin. On admission he had acute sinusitis, facial cellulitis and pyrorhea alveolaris. Exophthalmos of a moderate grade was observed after recovery from coma and a smoothly palpable thyroid. Roentgen rays of the head, chest, pelvis and left leg disclosed marked enlargement of the middle and outer tables of the skull. The frontal sinuses and maxillary sinuses were obliterated and the jaw was prominent. The pelvis showed marked cystic appearing areas as well as dense irregular striations and marked coxa vara. The femurs and left tibia also showed the same pathologic changes but to a lesser degree.

This patient showed severe diabetes and finally coma, together with enlargement of the mandible, as demonstrated by roentgen ray which was suggestive clinically of acromegaly. In addition there was exophthalmos, elevated basal metabolic rate and goiter which pointed toward the pituitary as a factor. This was supported by the insulin tolerance curve and, in addition, the lack of responsiveness to hypoglycemia suggested adrenal involvement. It is pointed out that precocious puberty in females having the disease cannot be directly attributed to pituitary tumors. Hypothalmic lesions are known to produce this type of precocious puberty. Study of this case, therefore, suggests a complex endocrine disturbance, possibly originating before birth and implicating the pituitary gland.—*James J. McCort.*

Taylor, Henry K. Aseptic necrosis in adults; caisson workers and others. *Radiology*, June, 1944, *42*, 550–469.

Roentgen examination of individuals who have worked in compressed air sometimes shows single or multiple infarcts in the shafts of long bones, with or without areas of aseptic necrosis in the joints. The disease caused by too sudden release from pressure after working in compressed air is variously described as caisson disease, aero-embolism or bends. The injury is caused by nitrogen bubbles liberated when the body is removed too rapidly from the compression chamber. Aero-embolism has been reported in aviators and deep-sea divers but they have not shown bone or joint changes.

But similar changes may be seen in the bones and joints of individuals who have never worked in compressed air. The author discusses 54 patients seen by him who had aseptic necrosis and bone infarcts; 13 of these were women. Of the 41 men, 12 had a history of continued exposure to compressed air, 1 a history of a single exposure and the rest no occupational history. Of the 13 patients who had worked under compressed air, some had

been subjected to sudden changes of pressure and had had symptoms of aero-embolism or bends. Others had not been subjected to sudden changes in pressure; some of these had had mild symptoms of decompression sickness and some did not.

Lesions of the bones and joints do not develop until some time after decompression. The bone lesions are generally asymptomatic; secondary arthritic changes resembling those of chronic hypertrophic osteoarthritis develop in the joints.

The lesions seen in the non-occupational group were the same as those in the occupational group and could not be differentiated roentgenologically. Illustrative roentgenograms are given. One of the cases of aseptic necrosis was in a patient who had sickle cell anemia and a history of polyarthritis. The etiology of the non-occupational cases is not known.

The bone lesions are generally multiple and often bilateral. They are more frequently extensive and multiple in caisson workers than in others. The reparative changes are generally greater in the non-occupational group.—*Audrey G. Morgan.*

Dickison, J. C., and Shannon, J. G. Fractures of the carpal scaphoid in the Canadian army. *Surg., Gynec. & Obst.*, Sept., 1944, *79*, 225–239.

This presentation is the result of a study of 257 cases of fractured carpal scaphoids occurring in a period of approximately three years in the Canadian Army Overseas.

Analysis of Study. The results of treatment in those cases diagnosed early are quite satisfactory: in the cases not diagnosed early the results of treatment leave much to be desired.

The results achieved in the treatment of the simple fresh waist fractures are excellent. Union occurred in all these cases. If such fractures are immediately immobilized and kept so for a sufficient length of time they will unite.

The problem does not lie in the treatment, but rather in the diagnosis—indeed, the major problems from fractured scaphoids arise from failure to make an early diagnosis. A fractured scaphoid may be suspected from clinical examination, but the diagnosis can be positively established or excluded only by roentgenograms. The latter must be taken in the anteroposterior, lateral and oblique positions. The oblique is the most important view. Immediately after injury it is often difficult to establish the diagnosis roentgenographically. Only a very faint fracture line may be seen. The diagnosis of sprained wrist should be made with the greatest of caution, and only after fracture of the scaphoid has been positively excluded by repeated roentgenographic examinations.

Displacement is a rare but serious complication and must be corrected. It may be a lateral deviation, a distraction of the fragments or an angulation, this last usually being a widening of the radial side of the fracture line.

When the proximal pole fractures which were diagnosed early are examined, three points stand out: (1) there were only 12 of these as compared with 125 waist fractures; (2) the average time required for union was twenty weeks, whereas in the waist fractures it was twelve weeks; (3) delayed union and non-union occurred relatively much more often in this group than in the waist fractures. In fractures of the proximal pole vascular disturbances are more common and frequently there is complete severance of the blood supply leading to the proximal fragment so that avascular necrosis occurs in this part of the bone. Avascular necrosis is not necessarily a precursor of non-union—it only delays union. Revascularization of the proximal fragment with subsequent union of the fracture may take place.

There were 70 cases in this series of 247 cases which were not diagnosed until at least two months after the injury. Twenty-seven patients in this group with late diagnoses were treated by immobilization, but in only 6 of these did union occur. No fracture united in which the diagnosis was made later than nine months after injury.

In the fractures that united following operation, fourteen weeks is the shortest period of immobilization; while in those that did not unite the plaster was often removed in less than fourteen weeks.

There is only one proved indication for the use of operation, and that is established non-union—sclerosis of the fracture margins. The technical difficulties of the operation are great, and it should be undertaken only after most serious consideration.

Whether or not multiple drill holes will hasten the revascularization of the fragment in which there is avascular necrosis and thus hasten the process of union cannot be determined from this study.

It is probably true that a fractured scaphoid never unites if left untreated.

Complete or partial excision is of no use in these fractures.

As has been said, the period required for healing in any fractured scaphoid may be very long.—*Mary Frances Vastine.*

MacAusland, W. Russell. Perilunar dislocation of the carpal bones and dislocation of the lunate bone. *Surg., Gynec. & Obst.*, Sept., 1944, *79*, 256–266.

The purpose of this paper is three-fold: (1) to emphasize again the importance of early diagnosis and treatment of dislocations that concern the lunate bone; (2) to describe in simple form the dislocations that concern the lunate bone; and (3) to present the observations and results in a series of 24 cases.

Types of Dislocation. The first type is the perilunar dislocation of the carpus in which the distal row of carpal bones is displaced around the lunate bone, while the latter retains its normal or practically normal relationship with the radius. The dislocation is usually upward and backward, and may be complicated by a fracture of the navicular bone or of a styloid process, although a perilunar dislocation toward the volar aspect is not unknown.

The second type is a dislocation of the lunate bone itself, usually volarward. When dislocated volarward, the lunate bone may be found to have pivoted on the intact volar radiocarpal ligament so that it lies rotated, usually about 90 degrees. In severe cases in which the volar radiocarpal ligament also is ruptured, the lunate may lie entirely free in the soft tissue in front of the forearm bones.

Mechanism. The generally accepted theory of the mechanism of both types of dislocation is as follows: A person falls on the outstretched hand, forcibly hyperextending the wrist. The distal row of carpal bones rides upwards and backwards. No true rotation of the lunate bone takes place because of the intact dorsal ligament and capsule. Thus the perilumar type of dislocation is produced. When the capitate bone (in the distal row of carpal bones) in its backward course is forced against the radial margin, the dorsal radiocarpal ligament is torn and the lunate bone is squeezed out of the socket. Thus the lunate type of dislocation is produced.

In the usual dorsal dislocation of the lunate bone, the mechanism is the reverse of that in volar dislocations. The injury is one of forcible hyperflexion of the hand.

Occurrence. These dislocations, although among the more common carpal injuries are not of frequent occurrence. Over a period of twenty-seven years, only 24 cases have come to the author's attention.

Clinical Features and Diagnosis. (1) History of fall on outstretched hand; (2) a prominence on anterior surface of the wrist; (3) fingers held in slight flexion; (4) wrist motion limited in flexion and fingers cannot be fully extended; (5) damage to median nerve indicated by tingling sensation, paresthesia or excruciating pain; (6) palpation of dislocated lunate bone under flexor tendons of the wrist; (7) if there is associated fracture of the navicular bone, pressure in the anatomical snuff-box elicits tenderness; (8) in dorsal or palmar perilunar dislocation of the carpal bones, a prominent ridge is palpated on the outer or under surface of the hand as the case may be.

The ultimate diagnosis lies with the roentgenogram. A true lateral view is needed to demonstrate the dislocated bone or bones and anteroposterior views to reveal any associated fractures.

Treatment. Early manipulative treatment gives excellent results. Excision of the lunate bone, on the whole, results in a useful wrist and hand. The author recommends operative reduction in uncomplicated dislocations of the lunate bone when manipulation fails or when the case is treated within six weeks of the injury. Dislocations of the lunate of more than six weeks' standing are best treated by operative excision.—*Mary Frances Vastine.*